PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04L 29/06, 29/08, H04M 11/06, G06F 9/445, 13/38	A1	(11) International Publication Number: WO 99/33243 (43) International Publication Date: 1 July 1999 (01.07.99)

(21) International Application Number: PCT/SG98/00099

(22) International Filing Date: 8 December 1998 (08.12.98)

(30) Priority Data:
08/994,279 19 December 1997 (19.12.97) US

(71) Applicant: VIVID TECHNOLOGY PTE. LTD. [SG/SG]; Blk 1003 Bukit Mearh Central, Redhill Industrial Estate #03–09, Singapore 159835 (SG).

(72) Inventors: LEONG, Khai, Weng, Peter; Blk 24, Teban Gardens Road #02–171, Singapore 600024 (SG). BHASKARAN, Sreedharan; Block 764, 54 Choa Chu Kang Street #06–279, Singapore 680764 (SG). SURESH, Pillappa; Block 760, 72 Street #09–330, Yishun, Singapore 760760 (SG). SHENG, Wang, Qing; Block 236, Choa Chu Kang Central #11–45, Singapore 680236 (SG).

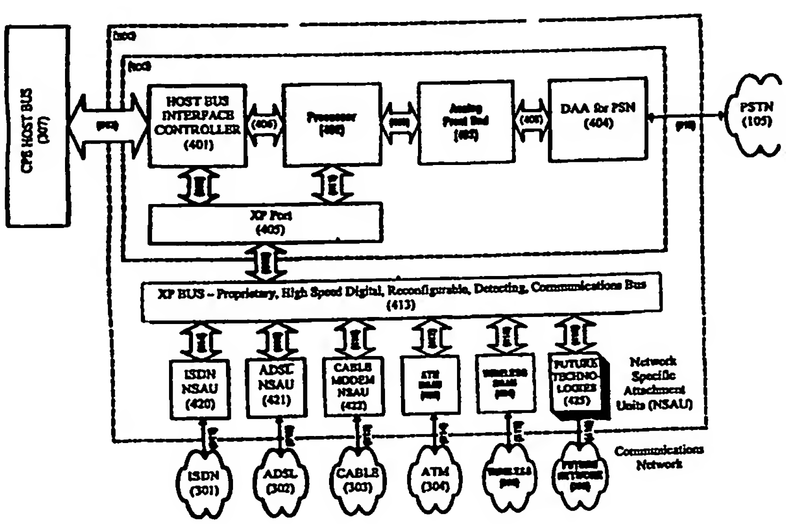
(74) Agents: HAQ, Murgiana et al.; Haq & Namazie Partnership, Robinson Road, P.O. Box 765, Singapore 901515 (SG).

(81) Designated States: JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: MULTIPROTOCOL RECONFIGURABLE NETWORK ADAPTER



(57) Abstract

A digital communications device having a dynamically reconfigurable extension port bus (XP BUS) for enables communication between customer premise equipment (CPE), such as personal computers (PCS), and network specific attachment units (NSAUs). The NSAUs, connected to the XP BUS, may vary and differ. A host adapter, including a host bus interface controller, couples the XP BUS to the CPE through a bus. The device may operate in any number of multiple different communications modes, and hybrids of such modes. The device automatically detects and identifies the presence and type of a particular NSAU and initiates the loading of appropriate software for, and reconfiguration of the XP BUS for compatibility with, the detected and identified NSAU. Software is downloaded from the CPE host to the host adapter and NSAUs. The XP BUS dynamically reconfigures. Multiple NSAUs may be supported by the XP BUS, as a result.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav	TM	Turkmenistan
BF	Burkina Faso	GR	Greece		Republic of Macedonia	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's	NZ	New Zealand		
CM	Cameroon		Republic of Korea	PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

MULTIPROTOCOL RECONFIGURABLE NETWORK ADAPTER

Field of the Invention

This application relates to data communication devices for the transmission and reception of data over Wide Area Networks (WANs). It includes, but is not limited to, analog modems, digital modems, ISDN terminal adapters, ADSL modems, Cable modems, ATM adapters, Wireless modem and other digital data communication devices for data transfer over the WAN.

Background of the Invention

Technology exists for enabling communication over WANs. Connecting to more than one WAN is difficult and there exist a number of prior art solutions, each with its own drawbacks, as described below.

Analog Modems

Modem stands for Modulator/DeModulator. An analog modem converts digital signals generated by a computer into analog signals which can be transmitted over a telephone line and converts incoming analog signals into their digital equivalents. The specific techniques used to encode the digital bits into analog signals are called modulation protocols. The various modulation protocols define the exact methods of encoding and the data transfer speed. A modem typically supports more than one modulation protocol, which it uses selectively depending on the remote device to which it is linked.

Some state-of-the-art modems are designed using a Digital Signal Processor (DSP) to perform the modulation and demodulation functions (the data pump). A software program that controls the DSP is stored in memory. Two common ways in which the memory can be implemented include:

(1) fixed memory: the memory is fixed and cannot be changed after the modem is manufactured without physically changing the memory chip(s). (2): open memory: such as flash memory is electrically changeable, but is not erased when power is off. This makes possible modem upgrades by software alone, either from the PC or the telephone network. This is a very flexible approach.

At one time, there was a cost differential between fixed memory and open memory, with open memory costing more. In the latest modem designs, this cost difference has become negligible. A modem with open memory makes possible user changes to the DSP program only if easy-to-use software supports the user's ability to access the new DSP program, load it and verify that all has been changed correctly. The combination of open memory, software and systems that allows a user to take advantage of the open memory is called Open Architecture. A modem with an Open Architecture makes it easy to introduce changes in the modem to accommodate upgrades.

Fig. 1 is a block diagram that illustrates the use of a prior art analog modem that is used for data transfer over the public switched telephone network **105** (PSTN). Digital data from the local CPE **100** is transmitted through channel **101** to the local analog modem **103**. Channel **101** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. The local analog modem converts the digital data to analog signals which it transmits through connection **104** to the PSTN **105**. The connection **104** is a twisted copper pair that is connected between the subscriber premises and the local telephone exchange. Modern implementation of an analog modem **103** employs the use of digital signal processors to perform the modulation process to convert digital data from the CPE to a digital representation of the analog signal (digital modulated signal) to be transmitted to the PSTN. An analog front end (AFE) and Data Access Arrangement (DAA) converts the digital modulated signal to an actual analog signal to be transmitted out through connection **104**.

At the remote end, the analog signals which have traversed the PSTN are received through **106** by the remote analog modem **107**. The remote analog modem demodulates and recovers the digital data from the received analog signal. The digital data is sent to the remote CPE via channel **108**. Channel **108** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. Data from the remote CPE to the local CPE travels in the reverse path through channels **109**, **106**, **104**, and **102**.

ISDN Terminal Adapters

An Integrated Services Digital Network (ISDN) line includes three digital channels: two "B" channels that carry various kinds of data at 64,000 bps and a "D" channel that carries data at 16,000 bps, which data may include control signals or additional data. A single ISDN B channel can transfer uncompressed data bidirectionally at 64,000 bps. Transmitting digital data over an ISDN does not need a modem data pump since no modulation or demodulation is necessary. An ISDN terminal adapter is needed to convert data from the local CPE to a digital format that is compatible with the 64,000 bps ISDN B channels. For example, the digital data from the local CPE is encapsulated in a bit-oriented protocol such as HDLC for transmission. Other bit-oriented protocols such as V.110 also may be used.

Fig. 2 is a block diagram that illustrates the use of a prior art terminal adapter for accomplishing data transfer over an Integrated Services Digital Network (ISDN) 206. Digital data from the local CPE **100** is transmitted through channel **201** to the local terminal adapter **205**. Channel **201** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. The local terminal adapter converts the data to an ISDN-compatible format, such as HDLC, and transmits it via channel **203** to the ISDN **206**.

At the remote end, the digital signals which have traversed the ISDN are received through channel **207** by the remote ISDN terminal adapter **209**. The remote terminal adapter converts the received digital data from ISDN to a format compatible with the remote CPE. Digital data is sent to the remote CPE **110** via channel **210**. Channel **210** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. Data from the remote CPE to the local CPE travels in the reverse path through channels **211, 208, 204,** and **202**.

Digital modems/Modecs

For connecting an existing telephone to ISDN, a voice-band terminal adapter (TA) is needed. The voice band TA converts the analog signals to digital PCM data for transmission over the B-channel. A normal analog modem also can be connected to the voice band TA for data communication with a remote analog modem connected to the PSTN. The analog modem and a

voice band terminal adapter (TA) can be combined into a single piece of equipment, called a digital modem or MODEC (modem + codec), which has no internal analogue functions and only digital interfaces. The interface to the DTE is the DTE's bit or character stream. The digital WAN interface is an octet stream which is the same as the PCM coding (according to ITU-T Recommendation G.711) of the voiceband signal at the analog (PSTN) interface of an equivalent modem. Internally, the digital modems convert digital data from the local CPE to a digital representation of the analog modulated signal. The digital modulated signal is converted to the ITU-T G.711 PCM format for transmission (for example from linear PCM to companded G.711 formats), for example.

Fig. 3 is a block diagram that illustrates the use of a prior art digital modem for communication between ISDN and a PSTN. The digital modem differs from an analog modem in that the digital representation of the analog signal (digital modulated signal) is not converted to the actual analog signal for transmission via a PSTN. Instead the digital modulated signal is converted to an ISDN compatible format such as pulse-code modulation (PCM), as defined by ITU-T recommendation G.711, for example. The network does the conversion from PCM to a PSTN analog signal.

Digital data from the local CPE **100** is transmitted through channel **220** to the local digital modem **222**. Channel **220** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. The local digital modem converts the digital data from the CPE to a digital modulated signal, PCM. PCM data is transmitted via channel **223** to the ISDN **206**. The ISDN **206** is interconnected with the PSTN **105**. The network performs conversion of PCM signals from the ISDN **206** to analog signal in the PSTN **105**.

At the remote end, the analog signals which have traversed the PSTN are received through channel **106** by the remote analog modem **107**. The remote analog modem demodulates and recovers the digital data from the received analog signal. The digital data is sent to the remote CPE **110** via channel **108**. Channel **108** may be part of a standard interface such as RS232 or a computer bus such as the ISA bus. Data from the remote CPE to the local CPE travels in the reverse path through channels **109, 106, 224,** and **221**. In the reverse path, the remote analog modem converts the digital data from the remote CPE **110** to analog signal, which is transmitted via channel **106** to the PSTN. The network converts PSTN analog signals to PCM data for transmission via the ISDN. At the local

digital modem, the PCM data is converted back to digital modulated signals and the demodulated to recover the digital data. The digital data then is sent via channel 221 to the local CPE.

ADSL modems

ADSL is a high speed digital network that uses existing twisted copper wire installations to homes that are currently being used for connection to the telephone. It also allows the exiting analog telephone service to co-exist on the same wire through a POT splitter. The CPE, which may be computer, is connected via an ADSL modem to the copper pair. The ADSL modem converts the digital data from the CPE into modulated signals for transmission over the copper pair. The modulation scheme used is different from that used by lower speed modems. ADSL modems occupy a much larger bandwidth and hence cannot transmit the signals through the PSTN. The ADSL modem analog signals are terminated at the remote end of the copper pair in a DSLAM (DSL access multiplexor). The digital data is recovered from the ADSL analog signal in the DSLAM. The digital data then is routed to a high-speed digital network.

Cable modems

Cable modems are designed to facilitate the implementation of data services over Hybrid Fiber Coax (HFC) cable networks, as well as over coaxial-only cable networks. The cable modem is situated at the interface of the cable network and the CPE. The CPE may include PCS, Macintoshes, workstations, network computers, and other electronic equipment. Digital data from the CPE is converted by the cable modem to analog signals which then are transmitted over the cable network to the head end. At the head end, the digital data is recovered from the analog signal and forwarded to a high speed digital network.

One characteristic of WANs is the plethora of technologies actually employed for data access. The technologies are so different that they do not allow a common physical interface design that is sufficiently cost effective to be employed for different WANs. For data access, the data pump and digital data processing sub-system actually can be reused over a variety of WANs. The prior art approach to connecting to more than one WAN is to design equipment with more that one physical

WAN interface. This approach entails eliminating the data processing sub-system with the physical interface of one WAN upon the use of a different WAN. Some prior art solutions to this problem allow for new physical interface modules to be plugged into a flexible back-plane or a card-socket, such as PCMCIA. This affords maximum flexibility, but increases the cost of the design in the case when the user only wants to access the PSTN using a modem first and then wants to upgrade to higher speed technologies later.

Until a ubiquitous, data-equivalent of a phone jack exists for the WAN, there always will be a need for flexibility in the WAN physical interface.

An object of the invention is to enable a user to alter his/her WAN physical interface without much encumberance and added cost, while still being able to retain his/her data processing hardware.

Summary of the Invention

The invention is directed to a digital communications device having a dynamically reconfigurable extension port bus (XP BUS) for enabling communication between customer premise equipment (CPE), such as personal computers (PCS), and network specific attachment units (NSAUs). The NSAUs, connected to the XP BUS, may vary and differ. A host adapter, including a host bus interface controller, couples the XP BUS to the CPE through a bus. The device may operate in any number of multiple different communications modes, and hybrids of such modes. The device automatically detects and identifies the presence and type of a particular NSAU and initiates the loading of appropriate software for, and reconfiguration of the XP BUS for compatibility with, the detected and identified NSAU. Software is downloaded from the CPE host to the host adapter and NSAUs. The XP BUS dynamically reconfigures. Multiple NSAUs may be supported by the XP BUS, as a result.

One embodiment of the invention is directed to a communications device for enabling communication between a host and an analog communications network. A host adapter, coupled to the host, communicates with the host. A dynamically reconfigurable extension port bus is coupled to the host adapter. The extension port is in a monitoring state, but is not used when connecting to

an analog PSTN. At least one network specific attachment unit is coupled to the extension port bus. Upon the coupling of a network specific attachment unit to the extension port bus, the extension port bus is dynamically reconfigured for compatibility with the network specific attachment unit and software appropriate for the network specific attachment unit is downloaded.

In one embodiment, at least one network specific attachment unit includes a plurality of network specific attachment units.

In an embodiment, the host adapter includes a host bus interface controller that communicates directly with the host.

In an embodiment, the host adapter includes a processor that implements software for reconfiguring the extension port bus.

In an embodiment, the host adapter includes an analog front end.

In an embodiment, the host adapter includes an extension port coupled to, and enabling communication with, the extension port bus.

In an embodiment, the network specific attachment unit is a digital communications device.

In an embodiment, the network specific attachment unit is an analog communications device.

Another embodiment of the invention is directed to a method for enabling communication between a host and at least one communications network in addition to an analog communications network. The method comprises the following steps:

coupling a host adapter between a host and a dynamically reconfigurable extension port bus so that it may communicate with the host and extension port bus;

enabling the coupling of at least one network specific attachment unit to the extension port bus;

determining a type of network specific attachment unit upon the coupling of the network specific attachment unit to the extension port bus;

dynamically reconfiguring the extension port bus for compatibility with the network specific attachment unit; and

and downloading software appropriate for the network specific attachment unit.

The features and advantages of the present invention will be more readily understood and apparent from the following detailed description of the invention, which should be read in

conjunction with the accompanying drawings and from the claims which are appended to the end of the detailed description.

Brief Description of the Drawing

For a better understanding of the present invention, reference is made to the accompanying drawings, which are incorporated herein by reference.

Fig. 1 is a block diagram illustrating a prior art implementation of Analog Modems.

Fig. 2 is a block diagram illustrating a prior art implementation of ISDN Terminal Adapters.

Fig. 3 is a block diagram illustrating a prior art implementation of Digital modems.

Fig. 4 is a block diagram of the invention.

Fig. 5 is a block diagram of the invention configured for operation as analog modem.

Fig. 6 is a block diagram of the invention configured for operation as an ADSL modem and analog modem.

Fig. 7 is a block diagram of the invention configuration for operation as ISDN terminal adapter, digital modem and analog modem.

Fig. 8 is a block diagram of the invention configuration for operation as cable modem and analog modem.

Fig. 9 is a block diagram of the invention configuration for operation as ATM adapter and analog modem.

Fig. 10 is a block diagram of the invention configuration for operation as Wireless modem and analog modem.

Fig. 11 is a block diagram of the XP BUS illustrating the signals received and transmitted.

Figs. 12A and 12B are flow diagrams illustrating operation of the software for the XP BUS.

Fig. 13 is a diagram illustrating the NSAU capability profile structure.

Description of the Invention

The invention is directed to a digital communications device having a dynamically reconfigurable extension port bus (XP BUS) for enabling communication between customer premise

equipment (CPE), such as personal computers (PCS), and network specific attachment units (NSAUs). The NSAUs, connected to the XP BUS, may vary and differ. a host adapter, including a host bus interface controller, couples the XP BUS to the CPE through a bus. The device may operate in any number of multiple different communications modes, and hybrids of such modes. The device automatically detects and identifies the presence and type of a particular NSAU and initiates the loading of appropriate software for, and reconfiguration of the XP BUS for compatibility with, the detected and identified NSAU. Software is downloaded from the CPE host to the host adapter and NSAUs. The XP BUS dynamically reconfigures. Multiple NSAUs may be supported by the XP BUS, as a result.

a general block diagram of the communications device of the invention is illustrated in Fig. 4. The invention allows for flexible interconnection to different communications networks. Although physically separated into different units, the apparatus logically functions as one system with a distributed processing architecture. The differentiating factor for this architecture from prior art is in both the hardware and software design. The XP BUS portion of the communications device of the invention allows for the apparatus to be reconfigured for different wide are networks. The bus does not merely function as a data interface but also functions as mechanism to allow cooperative distributed processing when two devices are connected together. This differs from prior art designs in which two interconnected data communications devices are normally capable of functioning independently and the interface defined between them is primarily for data interchange and synchronization only. The software design complements the hardware design in distributing its functionality in different physical sub-systems of the invention. For different NSAUs, the software would be partitioned differently.

As shown, **400** is a digital communications adapter with a dynamically reconfigurable extension port bus, XP BUS **413**, for connection to network specific attachment units (NSAUs) facilitating communications by the CPE over the respective networks. The customer premise equipment (CPE) may include, but is not limited to, personal computers, workstations, embedded controllers, network computers, set top boxes, and games consoles. The Host Bus Interface

Controller **401** allows the apparatus to be connected to a CPE bus and shall include, but is not limited to, PCI bus, PCMCIA/CardBus and USB.

The apparatus shall be able to operate in multiple modes, including (but not limited to) Public Switched Telephone Network (PSTN) DATA/VOICE/FAX modem, BRI ISDN adapter, PRI ISDN adapter, ADSL ATU-R, Cable modem, GSM/DECT adapter, ATM25 network interface and Frame Relay Access Device (FRAD). The apparatus also is able to take advantage of the host adapter processor to implement hybrid modes that involve analog modem modulation over a digital network; and includes (but shall not be limited to) V.34 over ISDN or FAX over ISDN connections. This allows for interworking with existing equipment over a public switched network.

The digital communication device **400** comprises the following elements.

1. a host bus interface controller **401**;
2. a processor **402** connected to the controller **401** and connected to the analog front end (AFE) **403**. The processor executes the analog data modem data pump software code, data switching functions, and other signal processing functions;
3. analog front end **403** coupled to the processor **402** and connected to the direct access arrangement (DAA) **404**;
4. DAA **404** connected through a socket to the PSTN;
5. XP port **405** (proprietary) connected to the processor **402** and the host bus interface controller **401**;
6. XP BUS **413** connected to XP port and network specific attachment units (NSAUs);
7. network specific attachment units (NSAUs) coupleable to the XP BUS **413**.

The apparatus can automatically detect and identify the presence of a particular NSAU and initiate loading appropriate software (e.g. protocol stacks) and reconfiguration of the XP BUS for the NSAU. Software to operate the adapter sub-system and NSAU sub-system is partitioned and executes in a distributed manner on the CPE host, the host adapter processor, and NSAU. The architecture allows for software to be downloaded from the computer host to the host adapter and NSAUs. The XP BUS (proprietary) self-configures dynamically to allow for different interface signal lines re-definitions depending on the NSAU connected. The XP BUS also sources power to

the NSAU device. The XP BUS shall be able to drive or be driven by a NSAU at 30 Megabits per second for a bus length of up to 2 meters, for example. The XP BUS shall allow for multiple devices to be physically connected.

Key features of the invention include:

1. Selectable WAN physical interface;
2. Scalable WAN Extension Bus — scalable in the sense that the cost increases with the speed required for the WAN interface; and
3. Reconfigurable software to drive different WAN technologies

The invention consist of two distinct sub-systems. The host adapter sub-system **500** comprises the host bus interface controller **401**, the processor **402**, the analog front end (AFE) **403**, DAA for PSTN **404**, and XP port **405**. The second sub-system is the XP BUS sub-system which comprises the XP BUS **413** and network specific attachment units (NSAUs) for the WAN. NSAUs include (but are not limited to) ISDN NSAU **420**, ADSL NSAU **421**, CABLE MODEM NSAU **422**, ATM NSAU **423**, WIRELESS NSAU **424**, and future NSAU **425**. Multiple NSAUs can be connected to the XP BUS at any instant but only one of the NSAUs can be activated for normal operation. Only one XP BUS **413** is connected to the host adapter through the XP port **405**. The XP BUS can operate in one of two modes: point-to-point with only one connected NSAU, and point-to-multipoint with multiple NSAUs connected.

Host adapter sub-system

The local CPE host bus **307** is connected to the host bus controller **401** through connector **317**. The host bus may include, but is not limited to, PCI, PCMCIA/Cardbus, and USB. The local CPE will run some software drivers for the system normally; for example, it may run V.42bis for the case of an analog modem and ISDN signaling for the case of a connected ISDN NSAU. The CPE host bus also is used to configure and download software to the processor in the host adapter sub-system **500**. Typically, the software downloaded includes the modem data pump code for the analog modem portion. When a NSAU is connected to the host adapter sub-system **500**, software for the NSAU may also be downloaded from the local CPE through the local host bus **317** and through the

configured XP BUS 413 to the NSAU. The host bus interface controller 401 is connected to the processor 402 through a connection 406. The processor is connected to the analog front end (AFE) 403 through connection 407. The AFE 403 is connected to the DAA 404 through connection 408. The XP port 405 is connected to the XP BUS 413. The XP port also is connected to the host bus interface controller 401 through 410 and the processor 402 through 411.

XP BUS sub-system

Acronyms and Abbreviations

EEPROM: Electrically Erasable Programmable Read Only Memory

XP: Accelerator Port

XPCM: XP Configuration Module

XPEM: XP Enumeration Module

XP BUS Signal Definition

There are 20 signals on the XP BUS (413), as shown in Fig. 11. They include the following, divided by category.

General Control Signal Group

1. Eeprom_Enable (O) (501)
2. NSAU_Reset (O) (502)
3. Shift_Register_Enable (I/O) (503)
4. Shift_Register_Latch_Enable (O) (504)
5. NSAU_Detect (I) (505)

High Speed Signal Group

1. Frame_Sync (I/O) (510)
2. Frame_Bit_Clock (I/O) (511)

3. Frame_Transmit_Data (O) (512)
4. Frame_Receive_Data (I) (513)

Low Speed Signal Group

1. Control_Channel_Enable (I/O) (521)
2. Control_Channel_Request (I/O) (522)
3. Control_Channel_Clock (I/O) (523)
4. Control_Channel_Transmit Data (O) (524)
5. Control_Channel_Receive Data (I) (525)

Power Signal Group

1. Power_Enable (O) (530)
2. 3 X Vcc (531), (532), (533)
3. 2 x GND (534), (535)

O = Output, I = Input, I/O = Input/Output Configurable

XP BUS (Point To Point) Operation

The operation mode of the processor is configured to download code from the host port. Upon power-up, host software, the operation of which will be described with reference to Figs. 12A and 12B, will reset the modem board and download boot loader code into the DSP. This boot loader code then cooperates with the host download driver to download the XP BUS Configuration Manager Module (XPCM).

The purpose of the XPCM is to perform NSAU detection, identification enumeration and configuration. It also cooperates with the host XP Enumerator Module (XPEM) for software dynamic reconfiguration and NSAU firmware download.

Operation starts at step 100 and moves to step 102 where the processor is configured. NSAU presence on the XP BUS (413) is detected at step 104 via the NSAU_Detect (505) signal. If no NSAU is present, then at step 108, the XPCM cooperates with the XPEM to download the modem

code and the board behaves as a modem. The XPCM remains resident to handle any hot insertions of NSAU, at step 110. If a NSAU insertion is detected at step 112, then the process moves through step a to step 114.

If a NSAU is detected by the XPCM, then NSAU is reset at step 114 and the XPCM determines the XP BUS (413) operation mode at step 116. The Shift_Register_Enable (503) is multiplexed to identify the XP BUS (413) operation mode at step 118. It is determined at step 118 whether the mode is point-to-multipoint. If so, then a point-to-multipoint procedure, described below, is carried out at step 126. If not, then it is determined to be in the point-to-point mode. In the point-to-point mode, the single NSAU is identified by reading the EEPROM contents of the NSAU at step 120. The EEPROM contains a capability profile (NSAUCP) which contains the following information:

1. a unique sequence to identify valid EEPROM data
2. a unique NSAU Identification (NSAUID)
3. a NSAU Revision Level Code
4. XPBUS (413) Resource Requirements
5. NSAU Specific Requirements
6. Checksum

The EEPROM is enabled for reading and writing via the Eeprom_Enable (501) signal and the contents are read via the Control Channel. The Control Channel is implemented via the Low Speed Signal Group and is configured as the master of the Low Speed Interface by the XPCM.

The XPCM communicates the NSAU to the XPCEM in the host at step 122. The XPCEM then determines if the software necessary for the NSAU is present in the system. If the software is present in the system, then the XPCM is instructed to reconfigure the XP BUS (413) according to the configuration requirements of the NSAU. XP BUS (413) configuration, at step 144, is achieved via the Shift_Register_Enable (503) and Shift_Register_Latch_Enable (504) signals together with the Control Channel. An important aspect of XP BUS (413) configuration and reconfiguration is the XP BUS (413) line driver configuration, at step 146, so that signal polarities are consistent to

prevent damage to the hardware pins. The port and pins are configured respectively in steps 148 and 150.

Once the XP BUS (413) has been configured, the High Speed and Low Speed signal groups of the XPBUS (413) are configured appropriately as required by the NSAUCP and instructed by the XPCEM. The completion of the configuration phase is signaled to the XPCEM at step 124.

If there is no appropriate NSAU software present on the host system, the XPEM does not initiate the XPBUS reconfiguration process. The NSAU draws quiescent power and is not active on the XP BUS (413).

Upon notification of detection of a NSAU, the XPEM determines if the appropriate software is available and initiates the configuration of the XP BUS (413) and the Signal Groups within the processor. At the same time, it dynamically loads the necessary host drivers for the NSAU. When the XPCM signals that the XP BUS (413) configuration is complete, the XPEM does the following :

1. downloads the appropriate NSAU and modem code (if combo operation is selected)
2. applies power to the NSAU via the Power_Enable (530) signal
3. resets the NSAU via the NSAU_Reset signal.
4. downloads NSAU firmware via the Low Speed Signal Group to the NSAU program RAM.
5. activates the host drivers

When a NSAU is removed, at step 130, the removal is detected immediately via the NSAU_Detect (505) and primary power to the NSAU is cut-off, at step 132. Configuration is reset at step 134. The removal is signaled to the XPEM at step 136 which then signals the NSAU specific drivers. The reconfiguration process is repeated when the NSAU is reattached or when another NSAU is attached, detected at step 138. If the NSAUCP indicates that the NSAU can be operated simultaneously with the modem data pump, then the modem functionality remains operational. NSAU is reset at step 140 and is reset on the XP BUS at step 142.

When a NSAU is attached to the XP BUS (413), power is immediately available to a small portion of the NSAU. Power enable to the XP BUS occurs at steps 152 and 154. This portion includes the EEPROM, shift register and latch to configure the XP BUS (413). Primary power is applied to the rest of the NSAU subsystem after the XP BUS (413) has been reconfigured. This

protects the NSAU line driver circuitry and reduces overall power consumption when the device is not enabled. NSAU power is controlled via the Power_Enable (530) signal and via the host power management protocol. Power is disabled to the XP BUS and it is reset at steps 156, 158 and 160.

The operation of the XP BUS in the point-to-multipoint mode is similar to the XP BUS point-to-point mode operation. The point-to-multipoint procedure is entered after the NSAU is reset (see Fig. 12A, step 126). When the XP BUS is in multipoint mode, device selection addressing information is sent out using the low speed signal group before reading the EEPROM contents. Only the NSAU with an address corresponding to the addressing information sent will respond to attempts to read the EEPROM contents. The XPCM will attempt to read all information from all of the connected NSAUs before going to the next phase. When the particular device is to be activated, the device selection addressing information is sent out to the NSAU. XP BUS configuration then proceeds from step 144 (as in point-to-point mode). Operation otherwise is similar to that in the point-to-point mode.

The contents of the EEPROM, shown in Fig. 13, are defined as a variable length structure comprising a fixed header and a variable length body of tuples with each tuple having a Type, Length and Value field.

The fields in the fixed header are :

1. NSAUCP Version
2. NSAUCP Length

and the Version 1.0 tuple Types are :

1. NSAUID
2. Profile Mask
3. Description
4. Manufacturer Code
5. Manufacturer Version

The NSAUCP Version field is 8 bits long and represents a Binary Coded Decimal (BCD) value representing the major version number in its higher nibble and the minor version number in its lower nibble, in one embodiment of the invention. The NSAUCP Version field is followed by the

NSAUCP Length field. This length indicates the extent of the NSAUCP data in the eeprom including the checksum field.

Figs. 5-10 are block diagrams illustrating alternate embodiments of the invention. Fig. 5 depicts the invention configured as a modem. Digital data from the local CPE is transmitted through the local CPE host bus 307 to the host bus interface controller 401 via connector 307. The physical form of connector 307 depends upon the CPE bus and host adapter. For an internal card design with a PCI bus, the connector 307 would simply consists of gold fingers connected to the PCI bus. In the case of an external design with a USB bus, the connector 307 would consists of the USB cable and sockets. The digital data is transmitted to the processor 402. Processor 402 is a digital signal processor that runs the modem data pump code.

Digital data from the local CPE is converted to the digital modulated signal, which is the digital representation of the analog modulated modem signal. The digital modulated signal is transmitted through 407 to the AFE. The AFE converts the digital modulated signal to an analog signal; that is digital-to-analog conversion of the modulated signal. The analog signal is transmitted through 408 to the DAA 404. The DAA 404 couples the analog signal onto the twisted copper pair 318 which transmits the analog signal to the PSTN 105. The analog signal traverses the PSTN to the remote analog modem 107. The digital data is recovered from the analog modulated signal and transmitted to the remote CPE 110. Data from the remote CPE 110 is transmitted as analog modulated signals to the PSTN to the local host adapter 500 through the twisted copper pair connection 318. Signal energy from the copper pair 318 is coupled via the DAA 404 to local host adapter 500.

The analog modulated signal is transmitted through 408 to the AFE 403. The AFE converts the analog signal to a digital representation. The digital modulated signal is transmitted from the AFE through 407 to the processor 402. The processor 402 performs the demodulation process which converts the digital modulated signal back to digital data. Digital data is transmitted to the host bus interface controller 401 through 406. The host bus interface controller 401 transfers the data through the local CPE host bus 307 to the local CPE via connector 317.

Fig. 6 depicts the invention configured for operation as ADSL analog modem. When the ADSL NSAU is connected through the XP BUS to the XP port, its presence is detected by the software drivers

on the local CPE. The configuration information from the XP port **405** is transmitted through **411** to the processor **402**. The processor interprets the information and transmits the configuration information via the host bus interface controller **401** to the local CPE. The XP BUS is then reconfigured via **410** and **411** connections to the host bus interface controller **401** and processor **402** respectively. Fig. 6 illustrates the fact that the host adapter sub-system **500** remains the same for the ADSL configuration. The functioning of the analog modem is identical to that described with reference to Fig. 5. Digital data from the local CPE is transmitted through the local CPE host bus **307** to the host bus interface controller **401** via connector **307**. The physical form of connector 307 depends upon the CPE bus and host adapter. For an internal card design with a PCI bus, the connector **307** would simply consists of gold fingers connected to the PCI bus. In the case of an external design with a USB bus, the connector 307 would consists of the USB cable and sockets.

The digital data is transmitted to the processor **402**. Processor **402** is a digital signal processor that runs the ATM AAL SAR code. Digital data is transmitted via **411** to the XP port **405** to the ADSL NSAU 421 through the XP BUS 413. The ADSL NSAU converts the digital data to a format compatible for transmission through the ADSL connection. The ADSL signal is transmitted via the copper pair **321** to the digital subscriber access multiplexor (DSLAM) **320**. The DSLAM is connected to a high speed digital backbone **324** via an internal set of connections **322 / 323**. The internal connections **322 / 323** may be an ATM connection to a ATM backbone.

Fig. 7 depicts the invention configured for operation as an ISDN terminal adapter and analog modem. When the ISDN NSAU is connected through the XP BUS to the XP port, its presence is detected by the software drivers on the local CPE. The configuration information from the XP port **405** is transmitted through **411** to the processor **402**. The processor interprets the information and transmits the configuration information via the host bus interface controller **401** to the local CPE. The XP BUS then is reconfigured via **410** and **411** connections to the host bus interface controller **401** and processor **402** respectively. Fig. 7, illustrates the fact that the host adapter sub-system **500** remains the same for the ISDN configuration. The functioning of the analog modem is identical to that described for Fig. 5.

Digital data from the local CPE is transmitted through the local CPE host bus **307** to the host bus interface controller **401** via connector **307**. The physical form of connector **307** depends upon the

CPE bus and host adapter. For an internal card design with a PCI bus, the connector 307 would simply consists of gold fingers connected to the PCI bus. For the case of an external design with a USB bus, the connector 307 would consists of the USB cable and sockets. The digital data is transmitted to the processor 402. Processor 402 is a digital signal processor that runs the ISDN HDLC code and D-channel physical interface driver code. Digital data is transmitted via 411 to the XP port 405 to the ISDN NSAU 420 through the XP BUS 413. The ISDN NSAU converts the digital data to a format compatible for transmission through the ISDN connection. The ISDN signal is transmitted via the copper pair 311 to the ISDN 206. The signal traverses the ISDN network and is received via 207 by the remote ISDN terminal adapter 209. The remote ISDN terminal adapter 209 converts the data to a format compatible with the remote CPE and transmits the data via 210 to the remote CPE 110.

Fig. 8 depicts the invention configured for operation as a Cable modem and analog modem. When the Cable modem NSAU is connected through the XP BUS to the XP port, its presence is detected by the software drivers on the local CPE. The configuration information from the XP port 405 is transmitted through 411 to the processor 402. The processor interprets the information and transmits the configuration information via the host bus interface controller 401 to the local CPE. The XP BUS is then reconfigured via 410 and 411 connections to the host bus interface controller 401 and processor 402 respectively. Fig. 8, illustrates the fact that the host adapter sub-system 500 remains the same for the Cable modem configuration. The functioning of the analog modem is identical to that described for Fig. 5.

Digital data from the local CPE is transmitted through the local CPE host bus 307 to the host bus interface controller 401 via connector 307. The physical form of connector 307 depends upon the CPE bus and host adapter. For an internal card design with a PCI bus, the connector 307 would simply consists of gold fingers connected to the PCI bus. For the case of an external design with a USB bus, the connector 307 would consists of the USB cable and sockets. The digital data is transmitted to the processor 402. Processor 402 is a digital signal processor that runs the Ethernet framing code. Digital data is transmitted via 411 to the XP port 405 to the Cable modem NSAU 422 through the XP BUS 413. The Cable modem NSAU converts the digital data to a format compatible for transmission through the cable network. The Cable modem signal is transmitted via the cable network 303 to the cable headend

330. The cableheadend is connected to a high speed digital backbone 324 via an internal set of connections 331 / 333. The internal connections 331 / 333 may be an ATM connection to a ATM backbone.

Fig. 9 depicts the invention configured for operation as ATM adapter and analog modem. When the ATM NSAU is connected through the XP BUS to the XP port, its presence is detected by the software drivers on the local CPE. The configuration information from the XP port 405 is transmitted through 411 to the processor 402. The processor interprets the information and transmits the configuration information via the host bus interface controller 401 to the local CPE. The XP BUS is then reconfigured via 410 and 411 connections to the host bus interface controller 401 and processor 402 respectively. Fig. 9, illustrates the fact that the host adapter sub-system 500 remains the same for the ATM configuration. The functioning of the analog modem is identical to that described for Fig. 5.

Digital data from the local CPE is transmitted through the local CPE host bus 307 to the host bus interface controller 401 via connector 307. The physical form of connector 307 depends upon the CPE bus and host adapter. For an internal card design with a PCI bus, the connector 307 would simply consists of gold fingers connected to the PCI bus. For the case of an external design with a USB bus, the connector 307 would consists of the USB cable and sockets. The digital data is transmitted to the processor 402. Processor 402 is a digital signal processor that runs the . Digital data is transmitted via 411 to the XP port 405 to the ATM NSAU 423 through the XP BUS 413. The ATM NSAU converts the digital data to a format compatible for transmission through the ATM connection. The ATM signal is transmitted via the connection 314 to the ATM network 304. The signal traverses the ATM network and is received via 351 by the remote ATM terminal adapter 350. The remote ATM terminal adapter 350 converts the data to a format compatible with the remote CPE and transmits the data via 352 to the remote CPE 110.

Fig. 10 depicts the invention configured for operation as Wireless terminal adapter and analog modem. When the Wireless NSAU is connected through the XP BUS to the XP port, its presence is detected by the software drivers on the local CPE. The configuration information from the XP port 405 is transmitted through 411 to the processor 402. The processor interprets the information and transmits the configuration information via the host bus interface controller 401 to the local CPE. The XP BUS

is then reconfigured via **410** and **411** connections to the host bus interface controller **401** and processor **402** respectively. Fig. 10, illustrates the fact that the host adapter sub-system **500** remains that same for the Wireless modem configuration. The functioning of the analog modem is identical to that described for Fig. 5.

Digital data from the local CPE is transmitted through the local CPE host bus **307** to the host bus interface controller **401** via connector **307**. The physical form of connector **307** depends upon the CPE bus and host adapter. For an internal card design with a PCI bus, the connector **307** would simply consists of gold fingers connected to the PCI bus. For the case of an external design with a USB bus, the connector **307** would consists of the USB cable and sockets. The digital data is transmitted to the processor **402**. Processor **402** is a digital signal processor that runs the wireless data pump code. Digital data is transmitted via **411** to the XP port **405** to the Wireless NSAU **424** through the XP BUS **413**. The Wireless NSAU converts the digital data to a format compatible for transmission through the Wireless connection. The Wireless signal is transmitted via the antenna **315** to the Wireless network **305**. The signal traverses the Wireless network and is received via antenna **207** by the remote Wireless terminal adapter **340**. The remote Wireless terminal adapter **340** converts the data to a format compatible with the remote CPE and transmits the data via **342** to the remote CPE **110**.

In sum, the invention allows for flexible interconnection to different communications networks. Although physically separated into different units, the apparatus logically functions as one system with a distributed processing architecture. The differentiating factor for this architecture from prior art is in both the hardware and software design. The primary hardware differentiation is the is XP BUS which allows for the apparatus to be reconfigured for different wide are networks. The bus does not merely function as a data interface between two communication sub-systems; for example an RS-232 interface. It also functions as mechanism to allow cooperative distributed processing when two devices are connected together. The bus allows the network specific attachment unit (NSAU) to be detected and appropriate software to be downloaded to operate it. In other words, the NSAU depends upon and operates cooperatively with the host adapter portion. This differs from prior art designs in which two interconnected data communications device are normally capable of functioning independently and the interface defined between them is primarily for data interchange and synchronization only. The close

coupling between the NSAU and host adapter portion reduces redundancy in the design of the entire system but allows for maximum flexibility in the network specific sub-system portion.

The software design complements the hardware design in distributing its functionality in the different physical sub-systems of the invention. For different NSAUs, the software would be partitioned differently. For instance, in the case ISDN, the signaling software would run primarily on the local CPE; the HDLC codecs required for ISDN B-channels data communication would run on the processor(DSP) in the host adapter; and the NSAU would be a primarily physical layer conversion device. In the case of ADSL, the ATM signaling software functions would run on the local CPE; the ATM AAL SAR functions would run on the processor(DSP) in the host adapter; and the ADSL modem functionality would be performed by the ADSL NSAU.

The invention includes the three major components: (1) host adapter, (2) XP BUS, and (3) NSAUs, characterized by the following.

1. A host adapter with a dynamically reconfigurable extension port bus, XP BUS, for connection to communication network specific attachment units (NSAUs) facilitating communications over the respective networks. The apparatus shall be able to operate in a multiplicity of modes, including (but not limited to) Public Switched Telephone Network (PSTN) DATA/VOICE/FAX modem, BRI ISDN adapter, PRI ISDN adapter, ADSL ATU-R, Cable modem, GSM/DECT adapter, ATM25 network interface, Frame Relay Access Device (FRAD), etc.

2. The apparatus is also able to take advantage of the host adapter processor to implement digital modem modes that involve analog modem modulation over a digital network, such as V.34 over ISDN or FAX over ISDN connections (inclusively but not limited to). This allows for interworking with existing equipment over a public switched network.

3. The host adapter comprises

a host bus interface controller;

a processor coupled to the controller and coupled to the analog front end (AFE). The processor executes the analog data modem data pump software code, data switching functions, and other signal processing functions;

analog front end coupled to the processor and coupled to the direct access arrangement (DAA);

DAA coupled through a socket to the PSTN;

XP port (proprietary) coupled to the processor and the host bus interface controller;

XP BUS coupleable to XP port and network specific attachment units (NSAUs);

network specific attachment units (NSAUs) coupleable to the XP BUS.

4. The host adapter can automatically detect and identify the presence of a particular NSAU and reconfigure the processor and computer host to load appropriate software (e.g. protocol stacks) and reconfigure the bus for the NSAU. Software to operate the adapter and NSAU is partitioned to reside on the computer host memory, the host adapter processor memory, and NSAU memory. The architecture allows for software to be downloaded from the computer host to the host adapter and NSAUs via overlay/paging operations; that is, the download may be performed upon reset or dynamically while the apparatus is in use. Overlay/paging operations reduce memory requirements for the processor and NSAUs.

5. The XP BUS (proprietary) is self-configures dynamically to allow for different interface signal lines re-definitions depending on the NSAU connected. The XP BUS is able to detect the presence of a connected NSAU and facilitate its identification. The XP BUS sources power to the NSAU device. The XP BUS shall be able to drive or be driven by a NSAU at 30 Megabits per second at a distance of up to 2 meters. The XP BUS shall allow multiple devices to be physically connected. The Host Bus Interface Controller allows the apparatus to be connected to a computer bus and shall include, but shall not be limited to, PCI bus, PCMCIA/CardBus and USB. By computer, we mean a generic device capable of storage, memory, I/O and computation operation, and hence includes (but not limited to) personal computers, workstations, embedded controllers, network computers, set top boxes, and games consoles.

6. Network Specific Attachment Units (NSAUs) are intended to be intelligent devices that are specific to a one (or more) wide area communication network (WAN). The NSAUs operate cooperatively with the host and host adapter processor. It is dependent on the host and host adapter

processor for reconfiguration and optional software download for its operation. Power for its operation shall also be optionally drawn through the XP BUS.

A summary of some of the features of the XP BUS follows. These features are exemplary and are not intended to limit the invention.

1. There are a total of 20 signals on the XP BUS.
2. There are 4 signals on the XP BUS that form the High Speed Signal Group.
3. There are 5 signals on the XP BUS that form the Low Speed Signal Group.
4. There are 5 signals on the XP BUS that form the General Control Signal Group.
5. There are 6 signals on the XP BUS that form the Power Signal Group.
6. The High Speed Signal Group can be reconfigured as a synchronous frame based communication channel with a common receive and transmit clock with either the processor or the NSAU as the clock source.
7. The High Speed Signal Group can be reconfigured as an asynchronous interface with individual clocks in the transmit and receive directions where the transmit clock is generated by the processor and where the receive clock is generated by the NSAU and vice versa.
8. The High Speed Signal Group can be reconfigured as a synchronous interface with individual clocks in the transmit and receive directions where the transmit clock is generated by the processor and where the receive clock is generated by the NSAU and vice versa.
9. The High Speed Signal Group can be reconfigured as a general purpose input and out programmable interface.
10. The Low Speed Signal Group can be reconfigured as a synchronous frame based communication channel with a common receive and transmit clock with either the processor or the NSAU as the clock source.
11. The Low Speed Signal Group can be reconfigured as an asynchronous interface with individual clocks in the transmit and receive directions where the transmit clock is generated by the processor and where the receive clock is generated by the NSAU and vice versa.

12. The Low Speed Signal Group can be reconfigured as a synchronous interface with individual clocks in the transmit and receive directions where the transmit clock is generated by the processor and where the receive clock is generated by the NSAU and vice versa.
13. The Low Speed Signal Group can be reconfigured as a general purpose input and out programmable interface.
14. The High and Low Speed Signal Groups can be reconfigured as one signal group to provide a combination of their individual modes.
15. The High Speed Signal Group can be used for NSAU firmware download during the NSAU configuration phase.
16. The Low Speed Signal Group can be used for NSAU firmware download during the NSAU configuration phase.
17. The XP BUS can selectively power the attached NSAU.
18. The XP BUS supports detection of NSAU insertion and removal.
19. The XP BUS supports dynamic detection of NSAU insertion and removal and dynamic configuration of NSAU while the adapter is being used as an analog modem.
20. The General Control Signal Group is used to control the High and Low Speed Signal direction configuration, detect NSAU presence and reset the NSAU.

Having thus described at least one illustrative embodiment of the invention, various alterations, modifications and improvements will readily occur to those skilled in the art. For example, while the invention was described listing specific exemplary protocols, bus widths, speeds of operation, data types and other characteristics, the invention need not be so limited. Such alterations, modifications and improvements are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims and the equivalents thereto

What is claimed is:

Claims

1. A communications device for enabling communication between a host and at least one communications network, comprising:

a host adapter, coupled to the host, that communicates with the host;

a dynamically reconfigurable extension port bus; and

at least one network specific attachment unit, coupled to the extension port bus;

wherein, upon the coupling of a network specific attachment unit to the extension port bus, the extension port bus is dynamically reconfigured for compatibility with the network specific attachment unit and software appropriate for the network specific attachment unit is downloaded.

2. The communications device claimed in claim 1 wherein the at least one network specific attachment unit includes a plurality of network specific attachment units.

3. The communications device claimed in claim 1 wherein the host adapter includes a host bus interface controller that communicates directly with the host.

4. The communications device claimed in claim 1 wherein the host adapter includes a processor that implements software for reconfiguring the extension port bus.

5. The communications device claimed in claim 1 wherein the host adapter includes an analog front end.

6. The communications device claimed in claim 1 wherein the host adapter includes an extension port coupled to, and enabling communication with, the extension port bus.

7. The communications device claimed in claim 1 wherein the network specific attachment unit is a digital communications device.

8. The communications device claimed in claim 1 wherein the network specific attachment unit is an analog communications device.

9. The communications device claimed in claim 1 wherein the extension port bus carries a plurality of signals from signal groups including a high speed signal group, a low speed signal group, a general control signal group and a power signal group.

10. The communications device claimed in claim 9 wherein the extension port bus, when carrying signals from the high speed signal group, may be reconfigured as at least one of the following: a synchronous frame-based communication channel having a common transmit and receive clock, an a synchronous interface communication channel having separate transmit and receive clocks, a synchronous interface communication channel with separate transmit and receive clocks, and a general purpose input and output programmable interface.

11. The communications device claimed in claim 9 wherein the extension port bus, when carrying signals from the low speed signal group, may be reconfigured as at least one of the following: a synchronous frame-based communication channel with a common transmit and receive clock, an asynchronous interface communication channel having separate transmit and receive clocks, a synchronous interface communication channel having separate transmit and receive clocks, and a general purpose input and output programmable interface.

12. The communications device claimed in claim 9 wherein the high speed signal group and the low speed signal group may be combined to form a single signal group yielding all modes achievable by both groups individually.

13. The communications device claimed in claim 9 wherein signals from the high speed signal group may include network specific attachment unit firmware being downloaded.

14. The communications device claimed in claim 9 wherein signals from the low speed signal group may include network specific attachment unit firmware being downloaded.

15. The communications device claimed in claim 1 wherein the extension port bus selectively powers the at least one network specific attachment unit.

16. The communications device claimed in claim 1 wherein the extension port bus supports detection of coupling and removal of a network specific attachment unit.

17. The communications device claimed in claim 1 wherein the extension port bus supports dynamic detection of coupling and removal of a network specific attachment unit and dynamic configuration of a coupled network specific attachment unit.

18. The communications device claimed in claim 1 wherein signals from the general control signal group are used to control directions of signals from the high speed signal group and the low speed signal group, control detection of a network specific attachment unit and resetting of a network specific attachment unit.

19. A digital communications device comprising:

a host adapter sub-system, coupled to an external host, that communicates with the host;

a extension port bus sub-system, including an extension port bus; and

at least one network specific attachment unit, coupled to the extension port bus, each network specific attachment unit being unique to a specific communications network;

wherein, upon the coupling of a network specific attachment unit to the extension port bus, the extension port bus is dynamically reconfigured for compatibility with the network specific attachment unit and software appropriate for the network specific attachment unit is downloaded.

20. A method for enabling communication between a host and at least one communications network, comprising the steps of:

coupling a host adapter between a host and a dynamically reconfigurable extension port bus so that it may communicate with the host and extension port bus;

enabling the coupling of at least one network specific attachment unit to the extension port bus;

determining a type of network specific attachment unit upon the coupling of the network specific attachment unit to the extension port bus;

dynamically reconfiguring the extension port bus for compatibility with the network specific attachment unit; and

and downloading software appropriate for the network specific attachment unit.

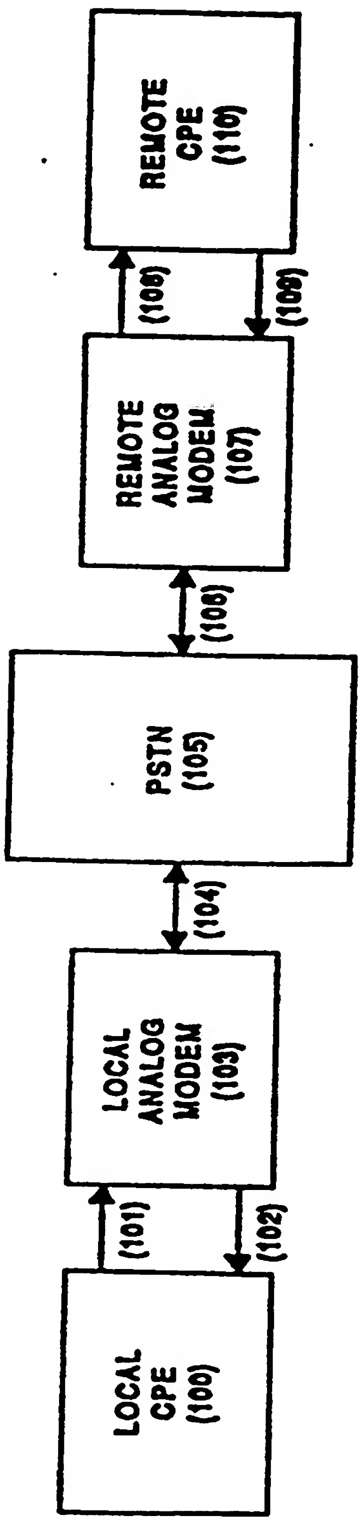


Figure 1 (PRIOR ART)

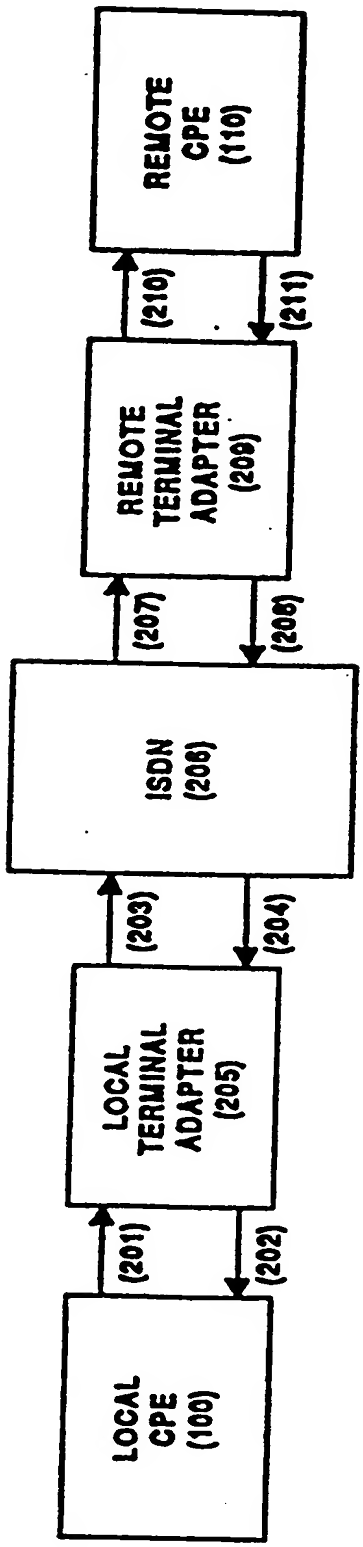


Figure 2 (PRIOR ART)

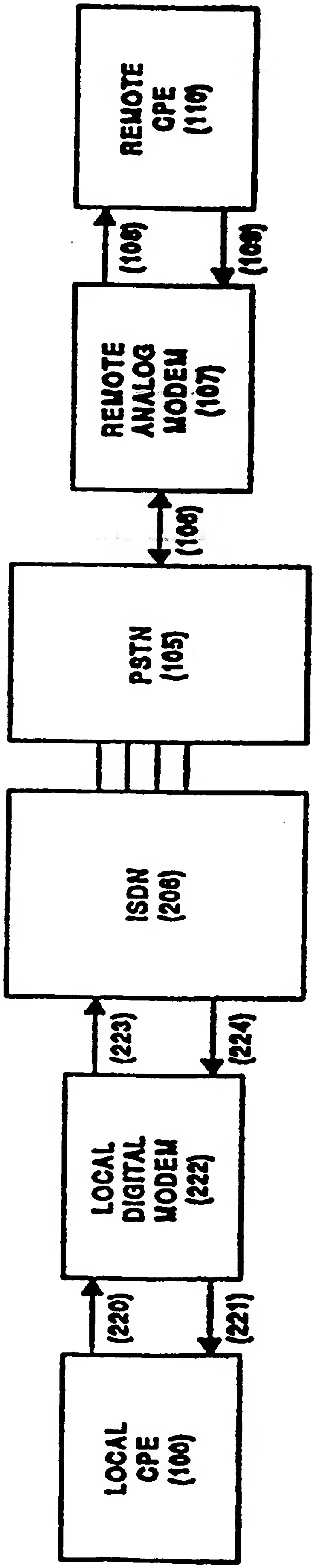


Figure 3 (PRIOR ART)

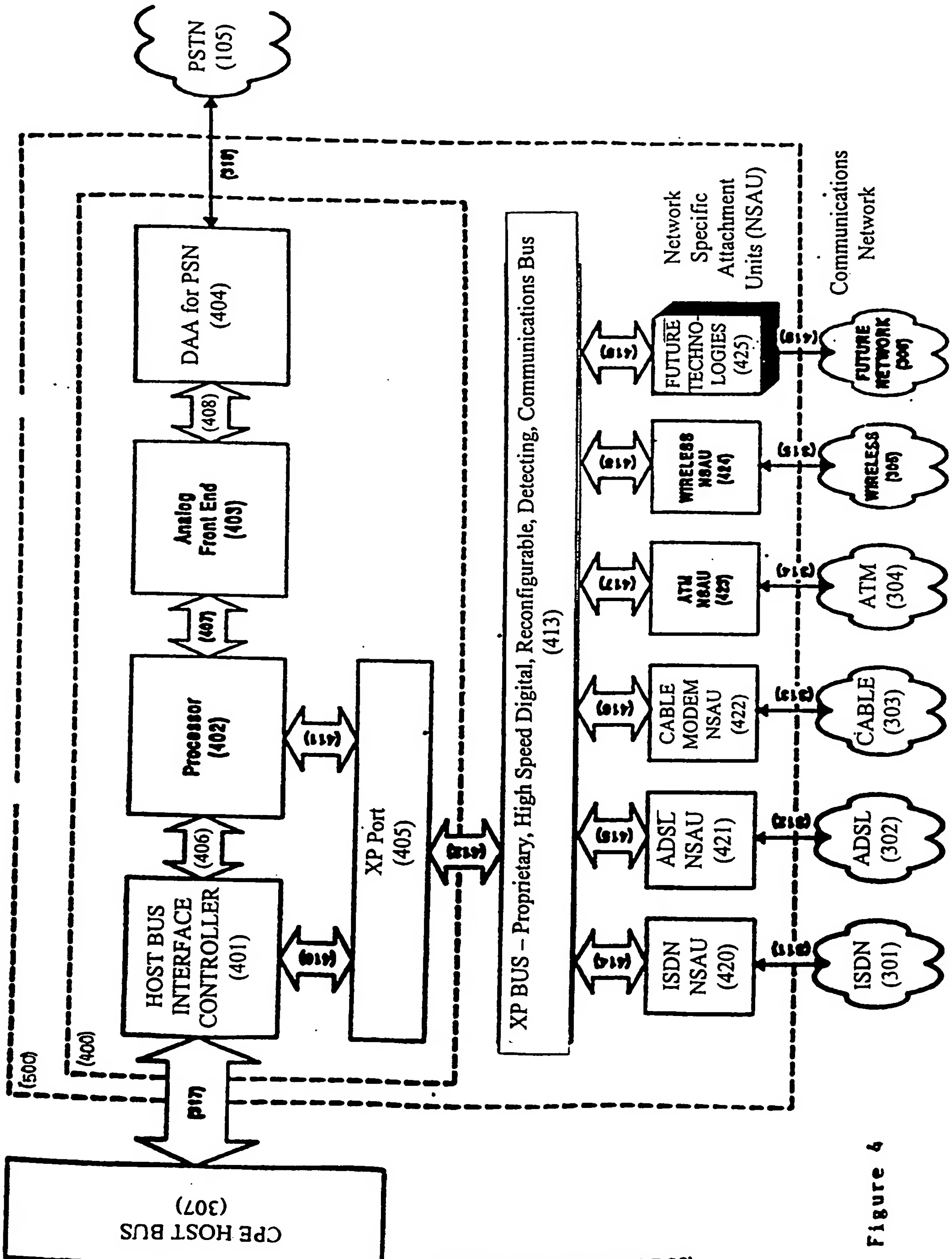

PSTN (105)
DAA for PSN (404)
(408)
Analog Front End (403)
(407)
Processor (402)
(406)
HOST BUS INTERFACE CONTROLLER (401)
XP Port (405)
(400)
(500)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
Network Specific Attachment Units (NSAU)
Communications Network
FUTURE TECHNO-LOGIES (425)
WIRELESS NSAU (424)
ATM NSAU (423)
CABLE MODEM NSAU (422)
ADSL NSAU (421)
ISDN NSAU (420)
FUTURE NETWORK (306)
WIRELESS (305)
ATM (304)
CABLE (303)
ADSL (302)
ISDN (301)
CPE HOST BUS (307)

Figure 4

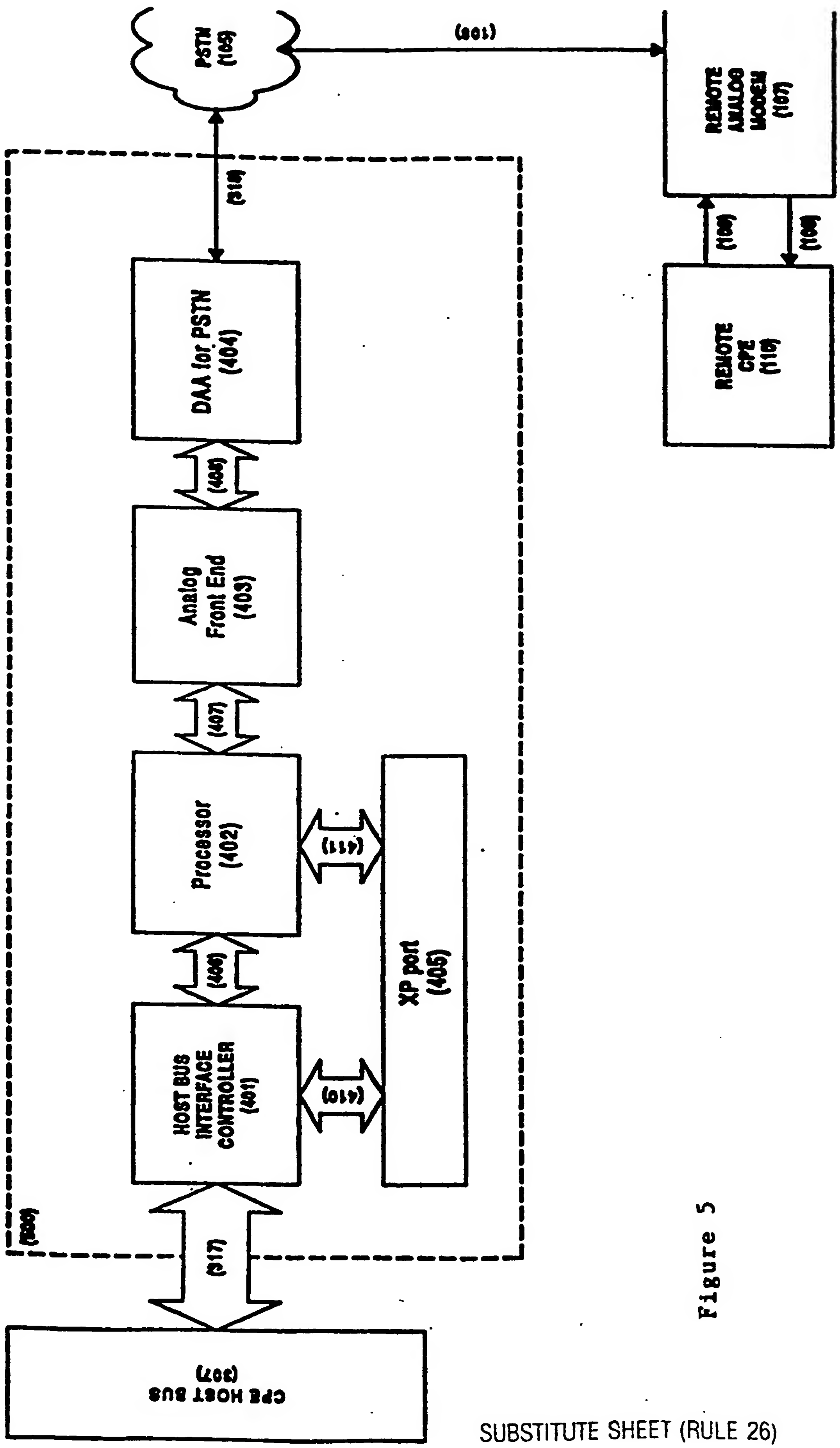

PSTN (105)
REMOTE ANALOG MODEM (107)
REMOTE CPE (110)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
HOST BUS INTERFACE CONTROLLER (401)
XP port (405)
(406)
(407)
(408)
(410)
(411)
(317)
CPE HOST BUS (307)

Figure 5

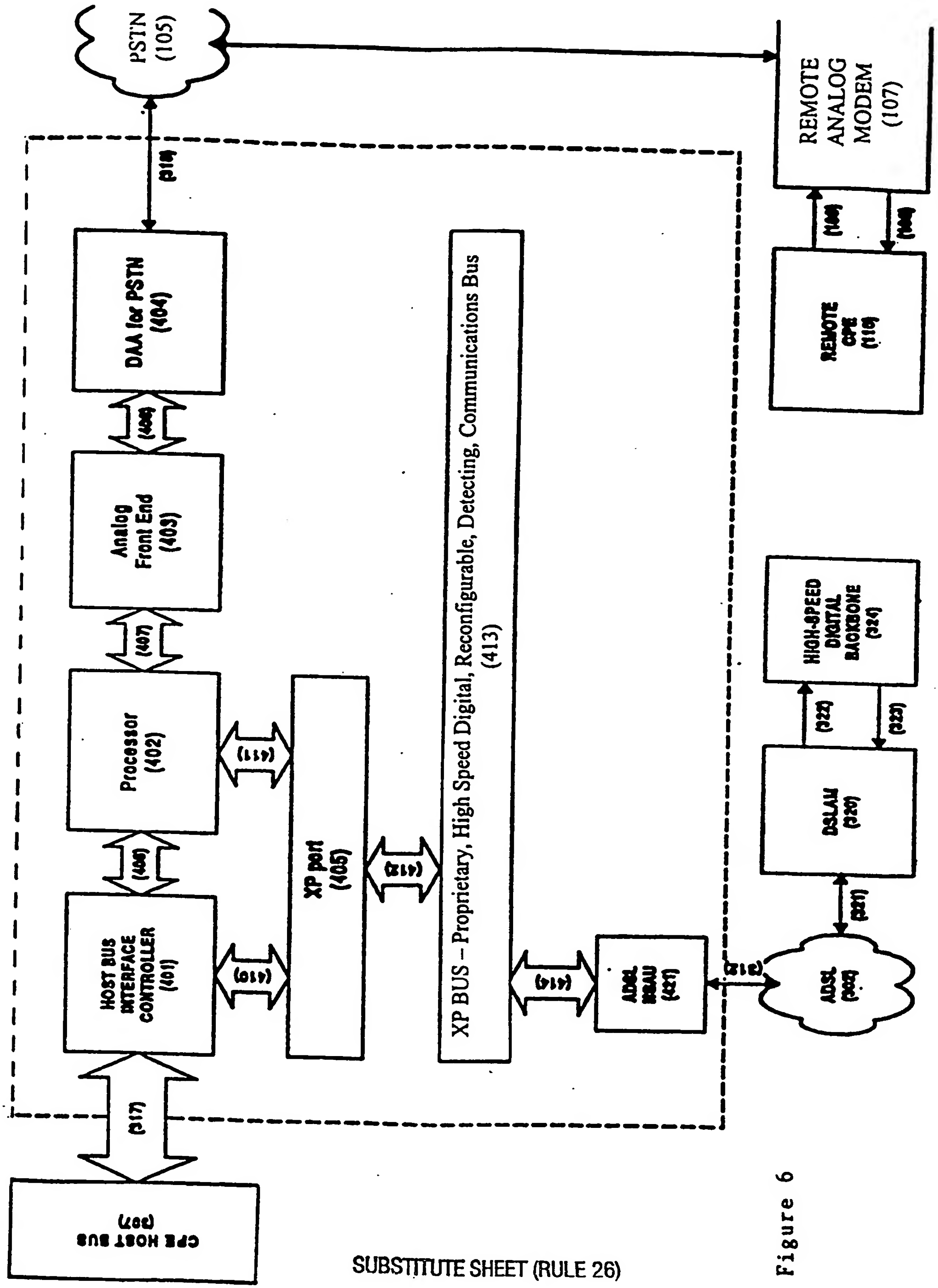

PSTN
(105)
REMOTE
ANALOG
MODEM
(107)
(318)
DAA for PSTN
(404)
REMOTE
CPE
(110)
(408)
Analog
Front End
(403)
(407)
Processor
(402)
(411)
XP port
(405)
(412)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
HIGH-SPEED
DIGITAL
BACKBONE
(324)
(322)
(323)
DSLAM
(320)
(321)
(409)
HOST BUS
INTERFACE
CONTROLLER
(401)
(410)
(414)
ADSL
RBAU
(421)
(312)
ADSL
(302)
(317)
CPE HOST BUS
(307)

Figure 6

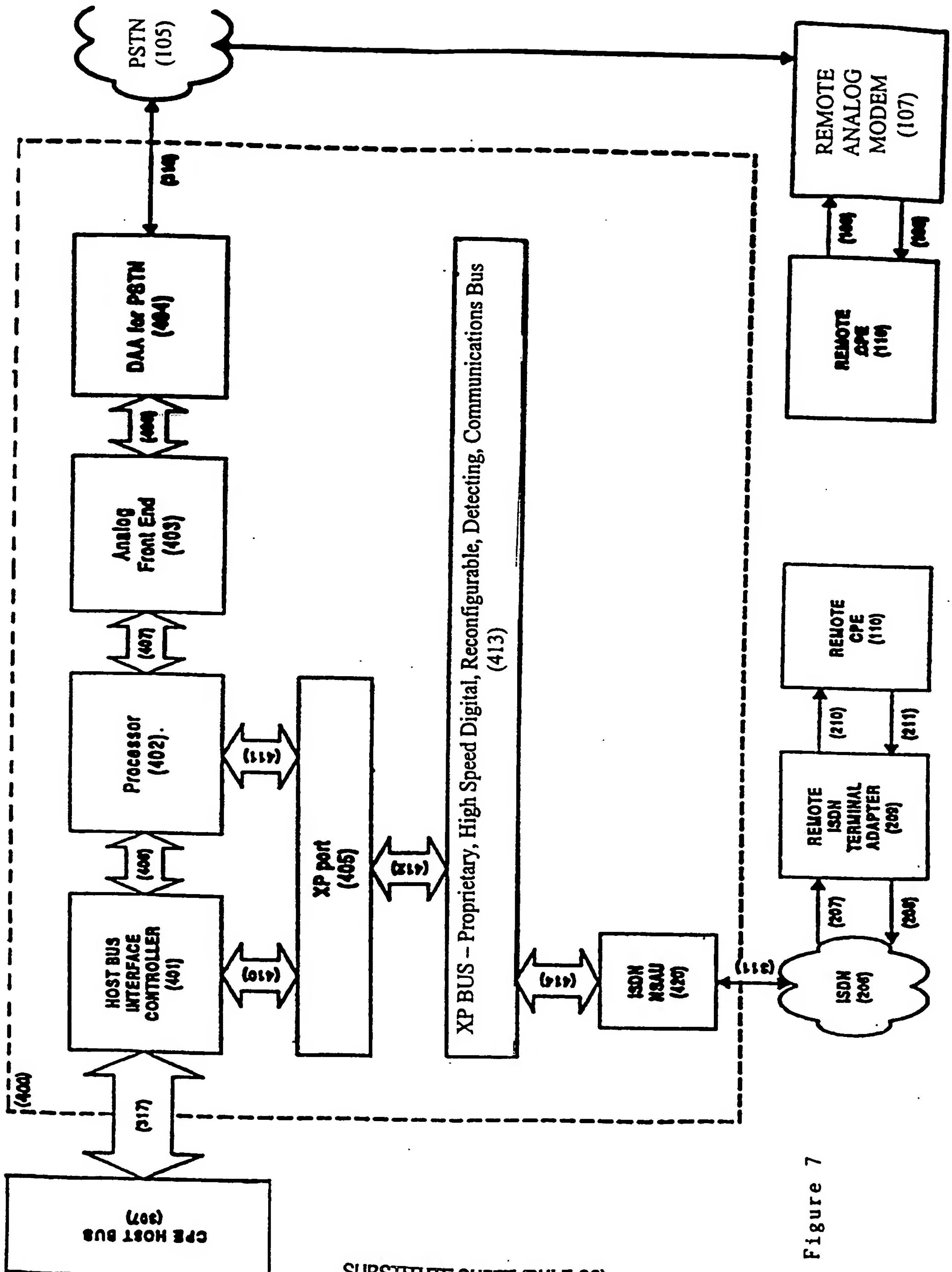

PSTN
(105)
REMOTE
ANALOG
MODEM
(107)
REMOTE
CPE
DAA for PSTN
(404)
Analog
Front End
(403)
(407)
Processor
(402)
(411)
XP port
(405)
(412)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
HOST BUS
INTERFACE
CONTROLLER
(401)
(406)
(410)
(414)
ISDN
NSAU
(420)
ISDN
(206)
REMOTE
ISDN
TERMINAL
ADAPTER
(209)
(207)
(210)
(211)
REMOTE
CPE
(110)
(400)
(317)
CPE HOST BUS
(307)

Figure 7

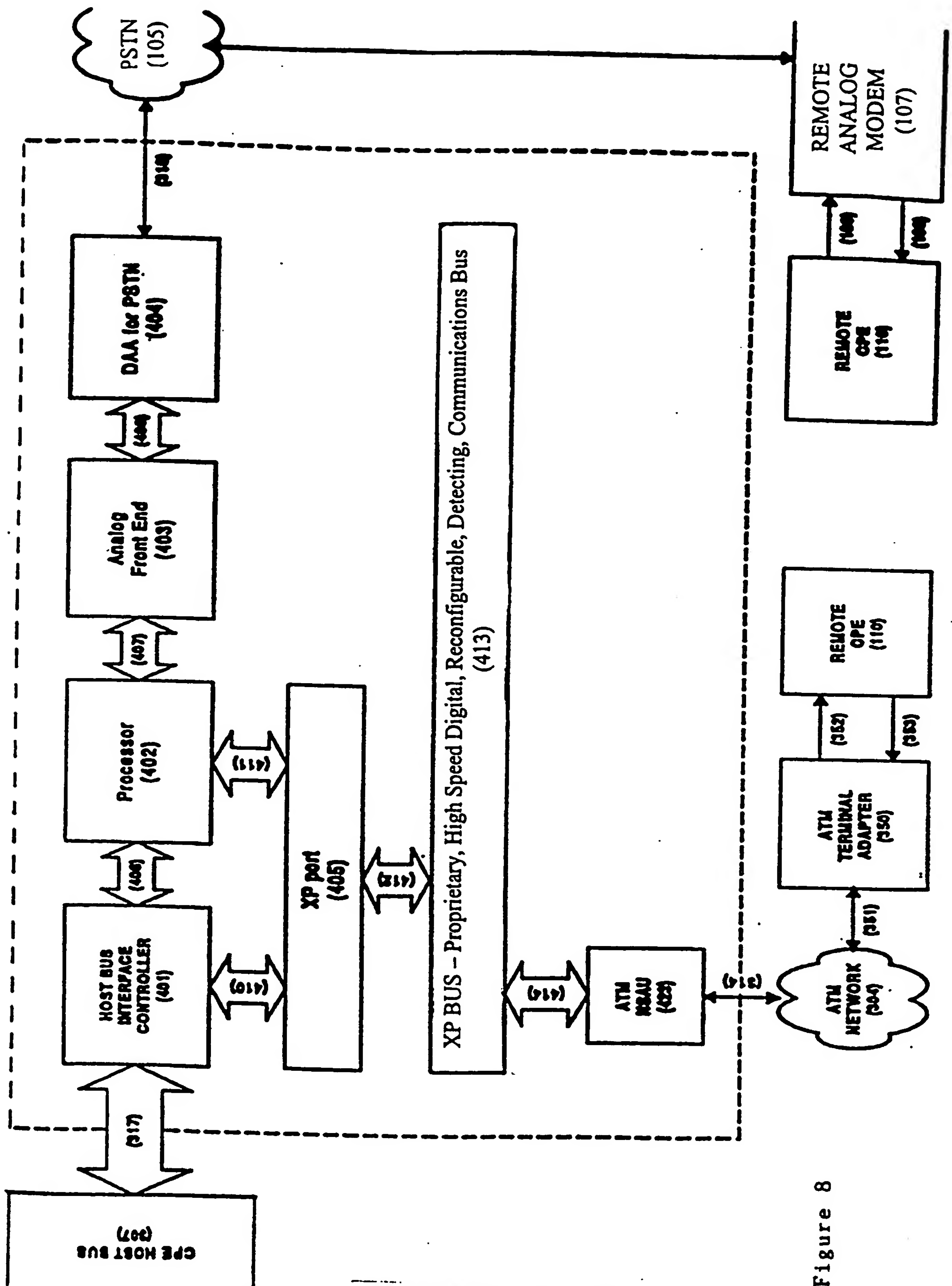
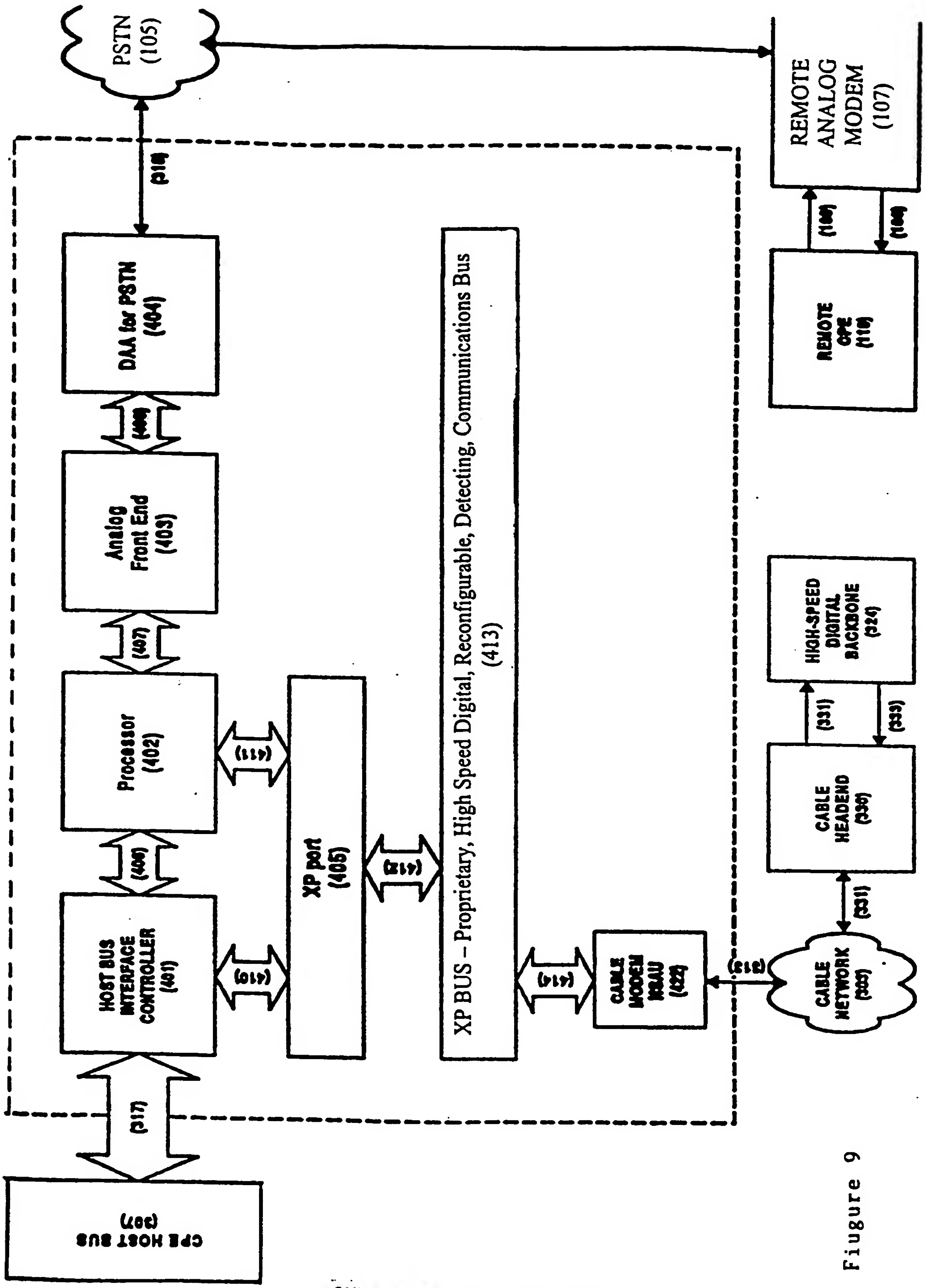

PSTN
(105)
REMOTE
ANALOG
MODEM
(107)
DAA for PSTN
(404)
Analog
Front End
(403)
(407)
Processor
(402)
(411)
HOST BUS
INTERFACE
CONTROLLER
(401)
(410)
XP port
(405)
(412)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
(414)
ATM
TERMINAL
ADAPTER
(350)
(352)
(353)
(351)
ATM
NETWORK
(304)
REMOTE
CPE
(110)
(317)
CPE HOST BUS
(307)

Figure 8


PSTN (105)
REMOTE ANALOG MODEM (107)
REMOTE CPE (110)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
HOST BUS INTERFACE CONTROLLER (401)
XP port (405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
CABLE MODEM NSAU (422)
CABLE NETWORK (303)
CABLE HEADEND (330)
HIGH-SPEED DIGITAL BACKBONE (324)
CPE HOST BUS (307)
(317)
(406)
(407)
(408)
(411)
(410)
(412)
(414)
(331)
(333)

Fiugure 9

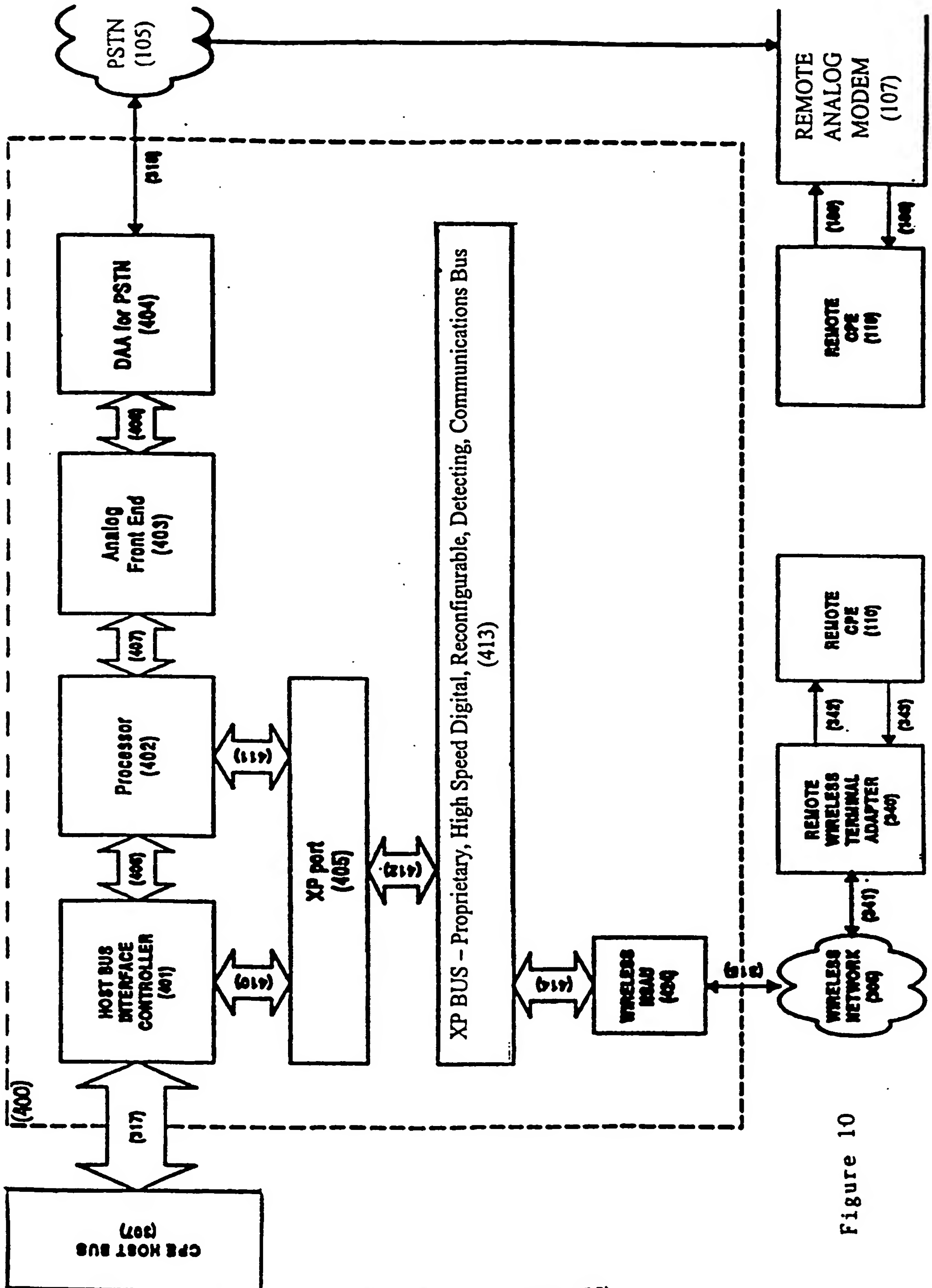

PSTN
(105)
REMOTE
ANALOG
MODEM
(107)
DAA for PSTN
(404)
Analog
Front End
(403)
Processor
(402)
HOST BUS
INTERFACE
CONTROLLER
(401)
XP port
(405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
REMOTE
CPE
(110)
REMOTE
WIRELESS
TERMINAL
ADAPTER
(340)
WIRELESS
NETWORK
CPE HOST BUS
(307)
(400)
(317)
(408)
(407)
(411)
(410)
(412)

Figure 10

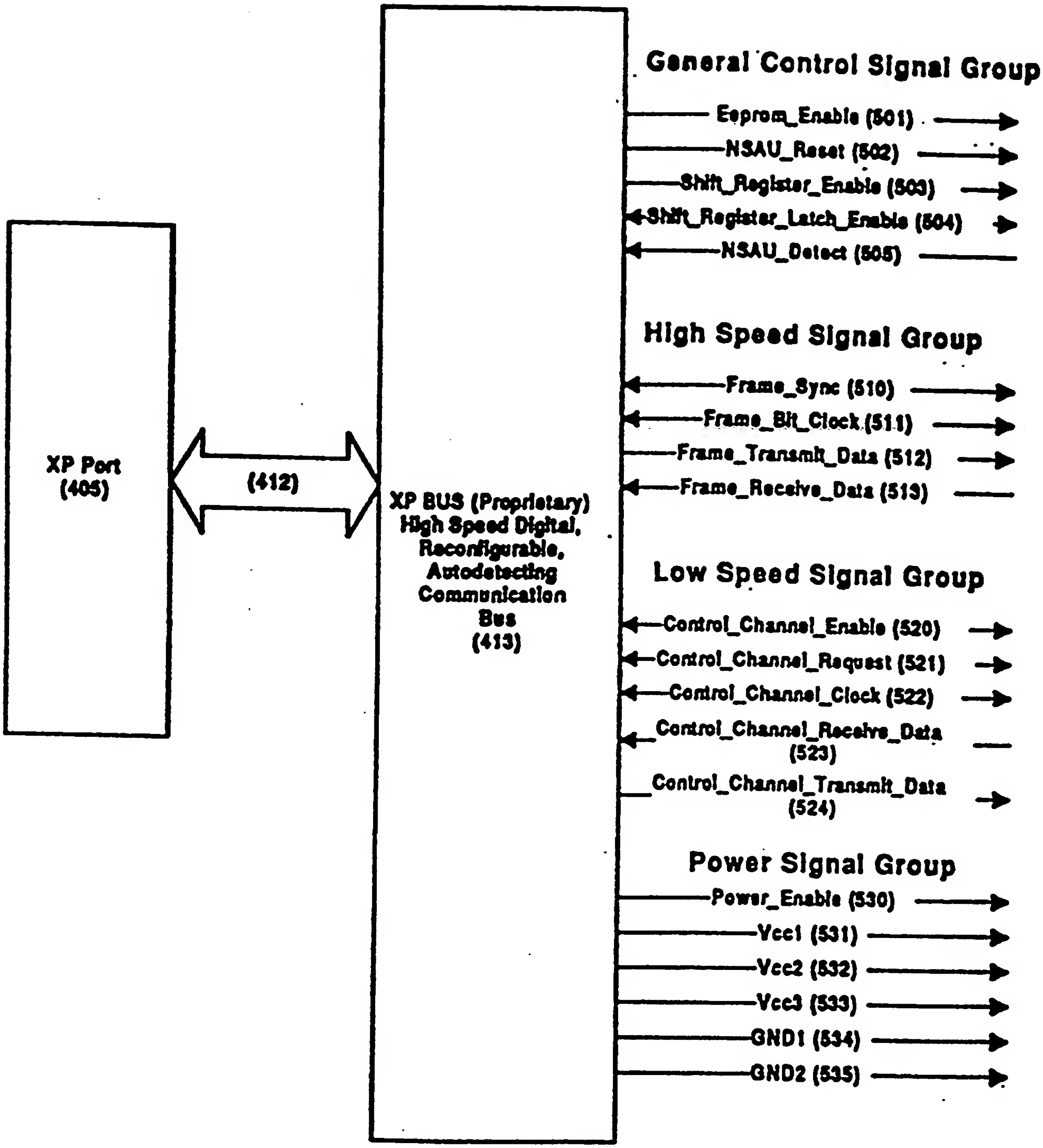


Figure 11. XP BUS Signals

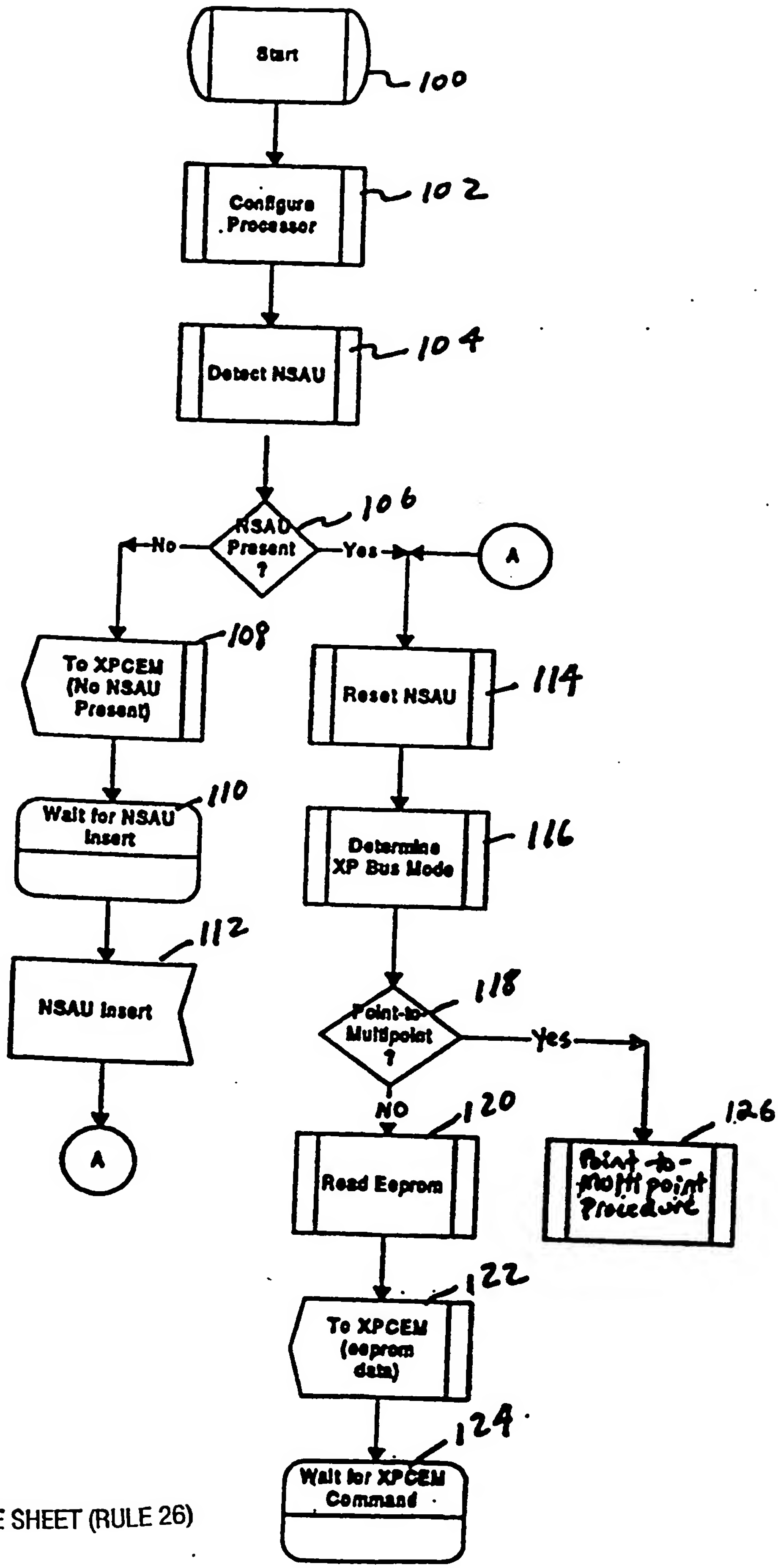

Start
100
Configure Processor
102
Detect NSAU
104
NSAU Present ?
106
No
Yes
A
To XPCEM (No NSAU Present)
108
Reset NSAU
114
Wait for NSAU Insert
110
Determine XP Bus Mode
116
NSAU Insert
112
Point-to-Multipoint ?
118
Yes
NO
A
Read Eeprom
120
Point-to-Multipoint Procedure
126
To XPCEM (eeprom data)
122
Wait for XPCEM Command
124

Figure 12A

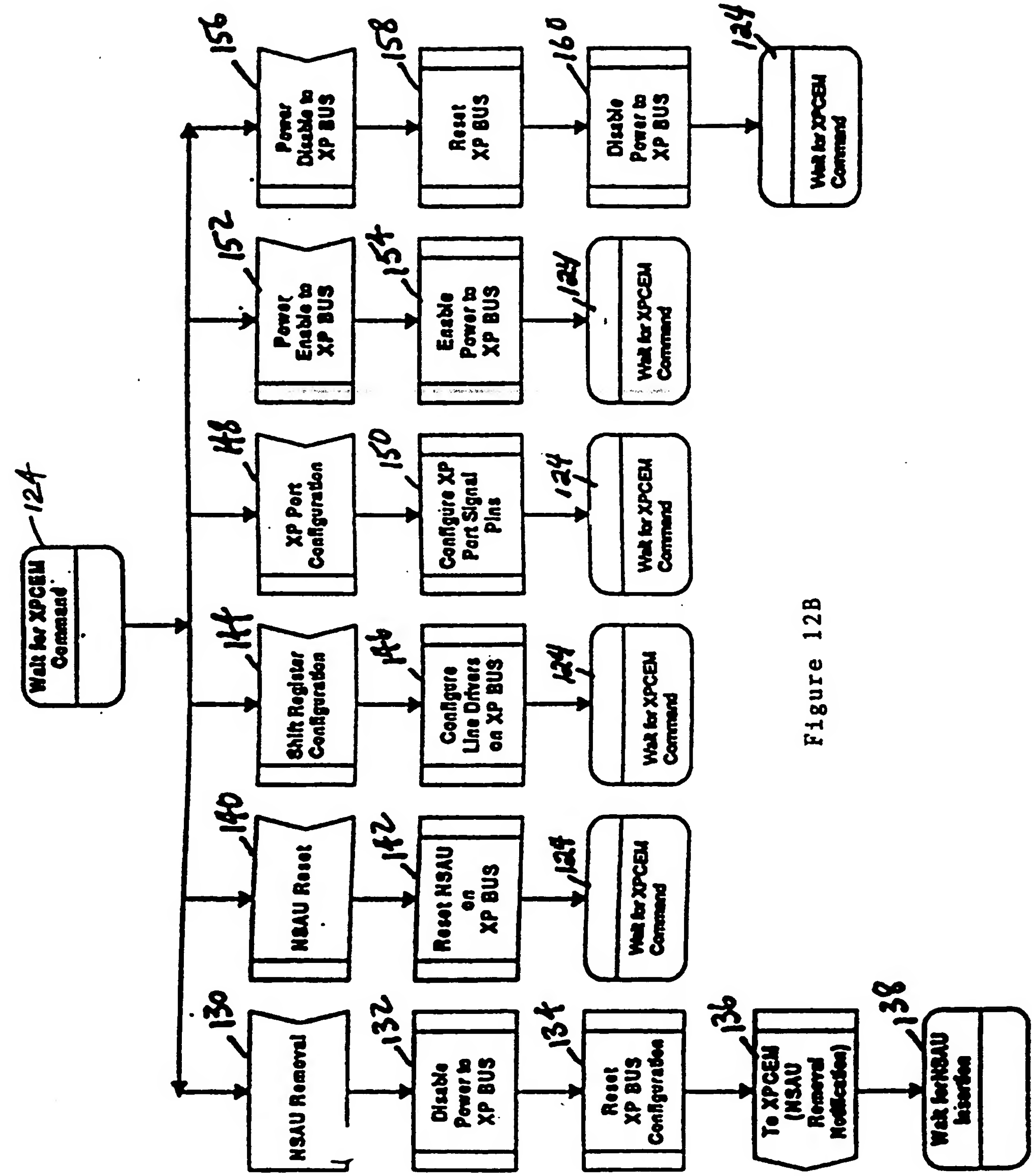

124
Wait for XPCEM Command
156
Power Disable to XP BUS
158
Reset XP BUS
160
Disable Power to XP BUS
124
Wait for XPCEM Command
152
Power Enable to XP BUS
154
Enable Power to XP BUS
124
Wait for XPCEM Command
148
XP Port Configuration
150
Configure XP Port Signal Pins
124
Wait for XPCEM Command
144
Shift Register Configuration
146
Configure Line Drivers on XP BUS
124
Wait for XPCEM Command
140
NSAU Reset
142
Reset NSAU on XP BUS
124
Wait for XPCEM Command
130
NSAU Removal
132
Disable Power to XP BUS
134
Reset XP BUS Configuration
136
To XPCEM (NSAU Removal Notification)
138
Wait for NSAU Insertion

Figure 12B

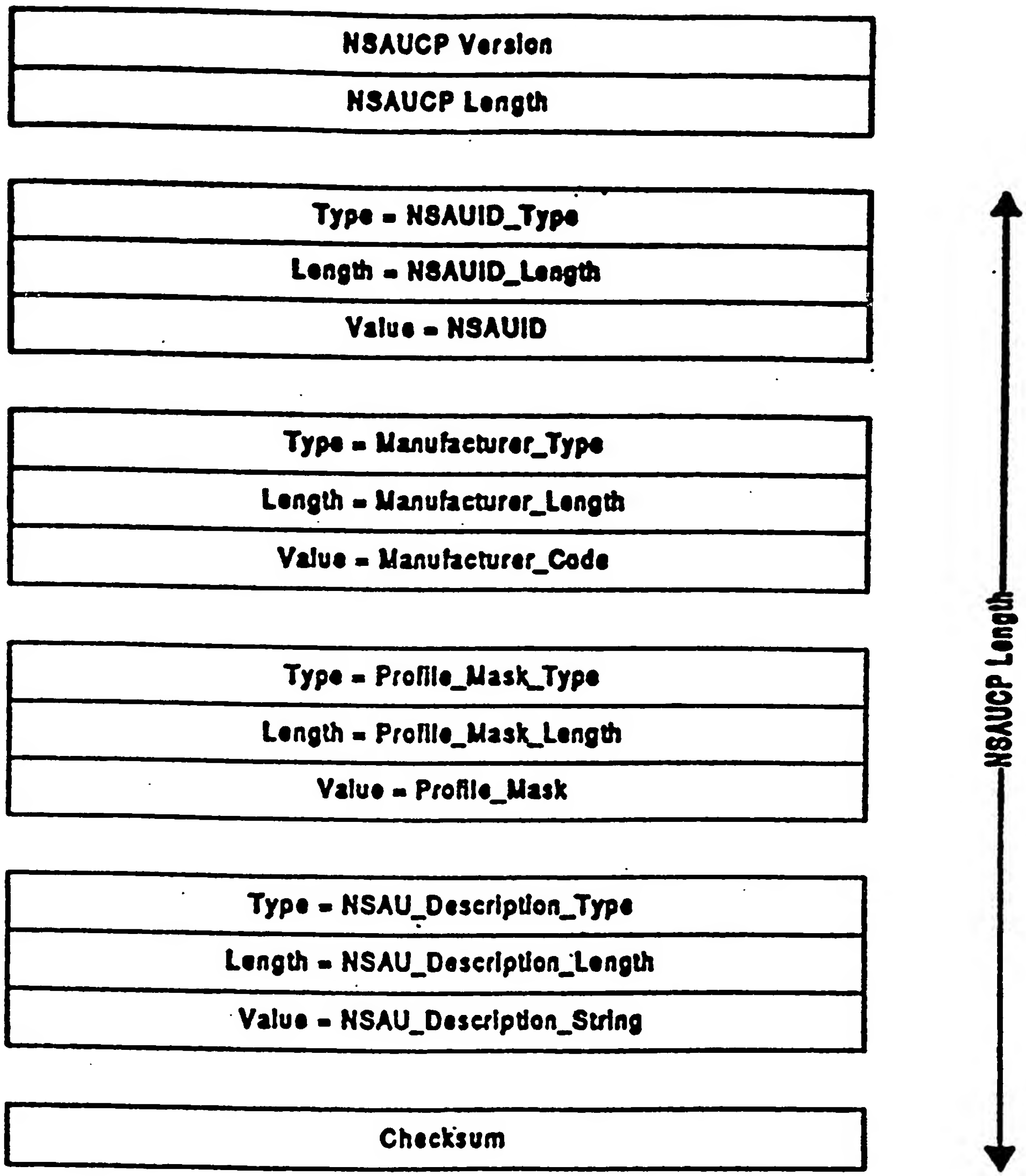


Figure 13. NSAU Capability Profile Structure

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SG 98/00099

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L29/06 H04L29/08 H04M11/06 G06F9/445 G06F13/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L H04M G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 515 760 A (IBM) 2 December 1992 see abstract see column 1, line 31 - line 39 see column 2, line 32 - line 56 see column 5, line 31 - line 49 see claims 6-9 ---	1,2,4,6, 7,16,19
Y	EP 0 436 458 A (IBM) 10 July 1991 see abstract see column 1, line 15 - line 35 see column 4, line 24 - line 38 ---	1,2,4,6, 7,16,19
A	EP 0 259 659 A (IBM) 16 March 1988 see column 1, line 6 - line 11 see column 5, line 10 - line 36 see column 4, line 42 - column 7, line 53 --- -/--	1,5,8,19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 1999	04/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Perez Perez, J

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SG 98/00099

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 639 916 A (IBM) 22 February 1995 see column 5, line 28 - line 39 see claims 15-18 -----	1,19,20

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

In ational Application No
PCT/SG 98/00099

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0515760 A	02-12-1992	DE 69117498 D	04-04-1996
		US 5235639 A	10-08-1993
EP 0436458 A	10-07-1991	JP 1946023 C	10-07-1995
		JP 3204749 A	06-09-1991
		JP 6073122 B	14-09-1994
EP 0259659 A	16-03-1988	JP 63064133 A	22-03-1988
EP 0639916 A	22-02-1995	US 5568525 A	22-10-1996
		JP 2510080 B	26-06-1996
		JP 7064894 A	10-03-1995

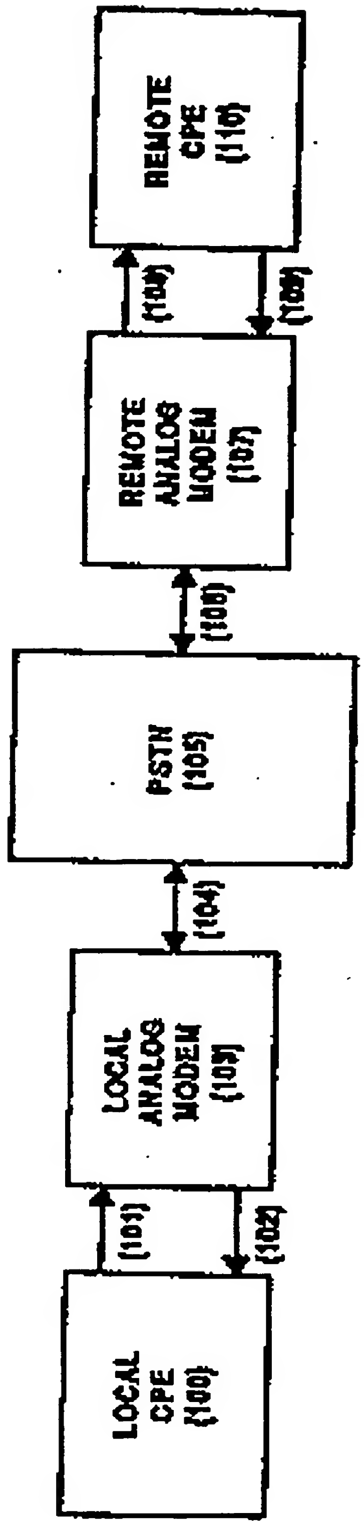


Figure 1 (PRIOR ART)

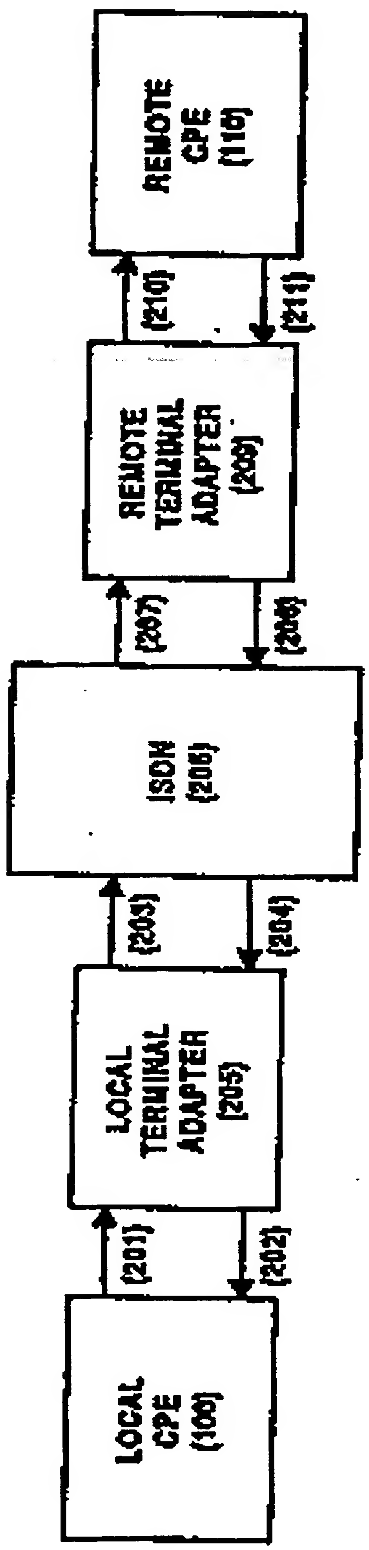


Figure 2 (PRIOR ART)

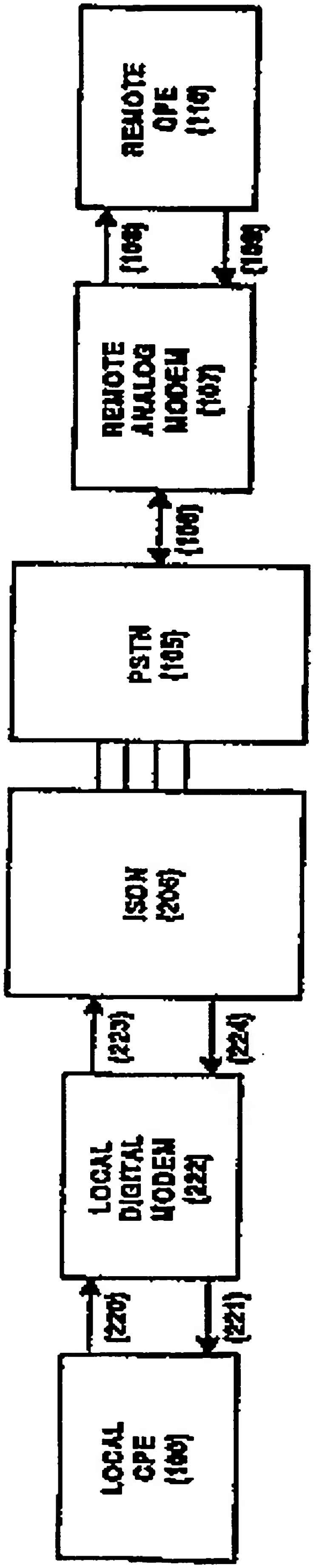


Figure 3 (PRIOR ART)

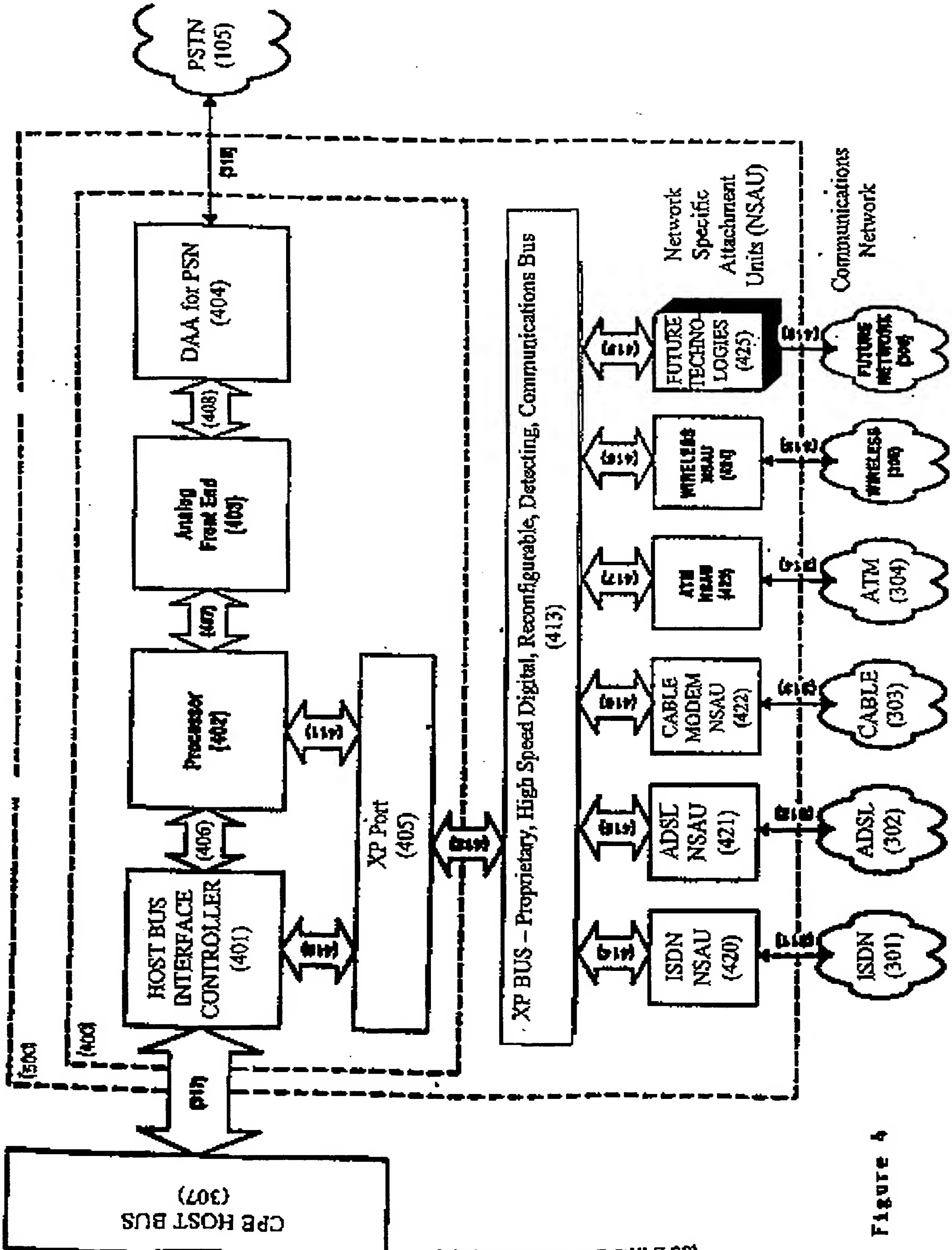

PSTN
(105)
DAA for PSN
(404)
(408)
Analog
Front End
(403)
(407)
Processor
(402)
(406)
HOST BUS
INTERFACE
CONTROLLER
(401)
XP Port
(405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
ISDN
NSAU
(420)
ADSL
NSAU
(421)
CABLE
MODEM
NSAU
(422)
FUTURE
TECHNO-
LOGIES
(425)
Network
Specific
Attachment
Units (NSAU)
Communications
Network
ISDN
(301)
ADSL
(302)
CABLE
(303)
ATM
(304)
CPE HOST BUS
(307)

Figure 4

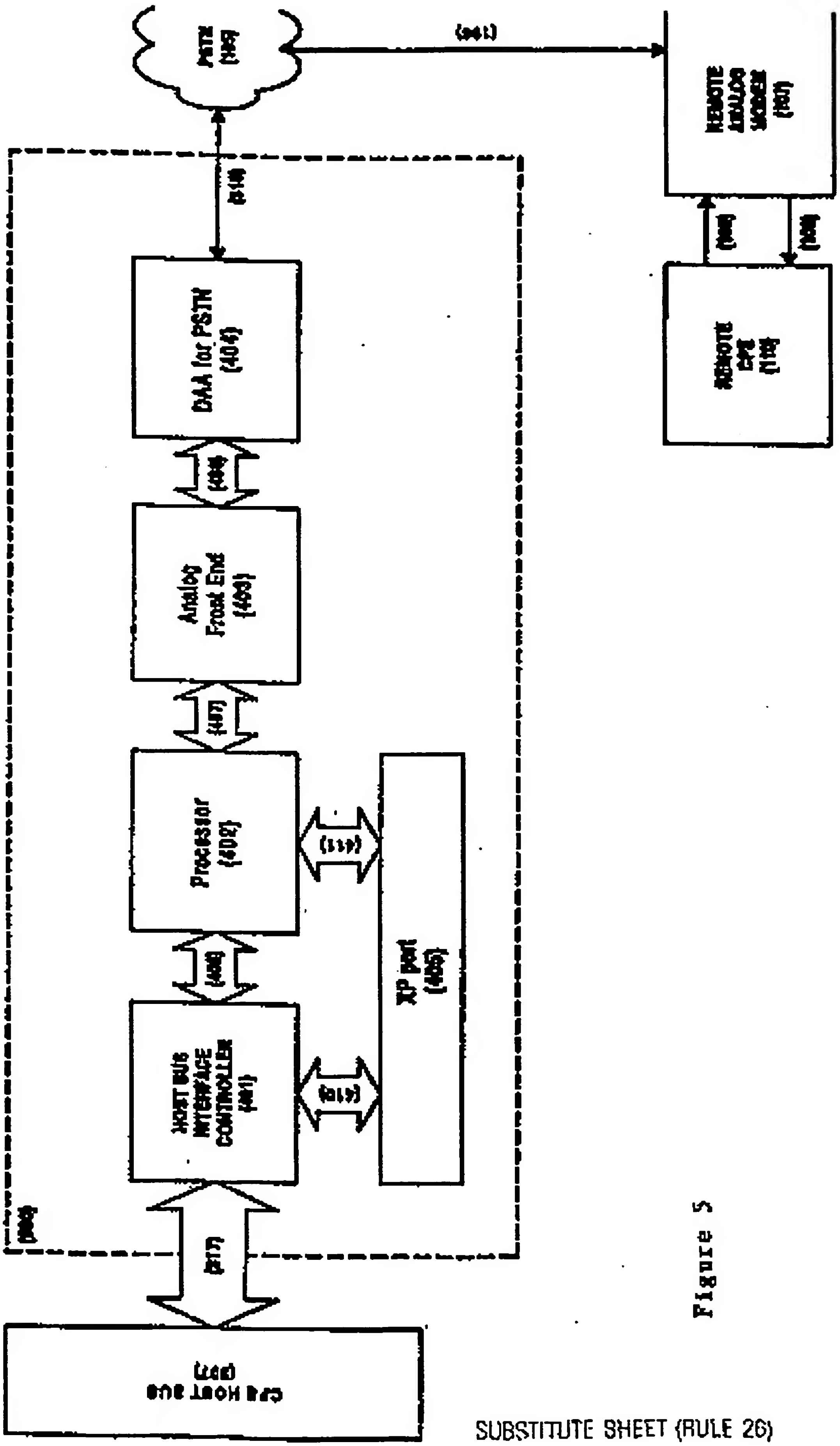

PSTN
DAA for PSTN (404)
Analog Front End
Processor (402)
XP port (405)
HOST BUS INTERFACE CONTROLLER
CPU HOST BUS
REMOTE ANALOG MODEM
REMOTE CPE

Figure 5

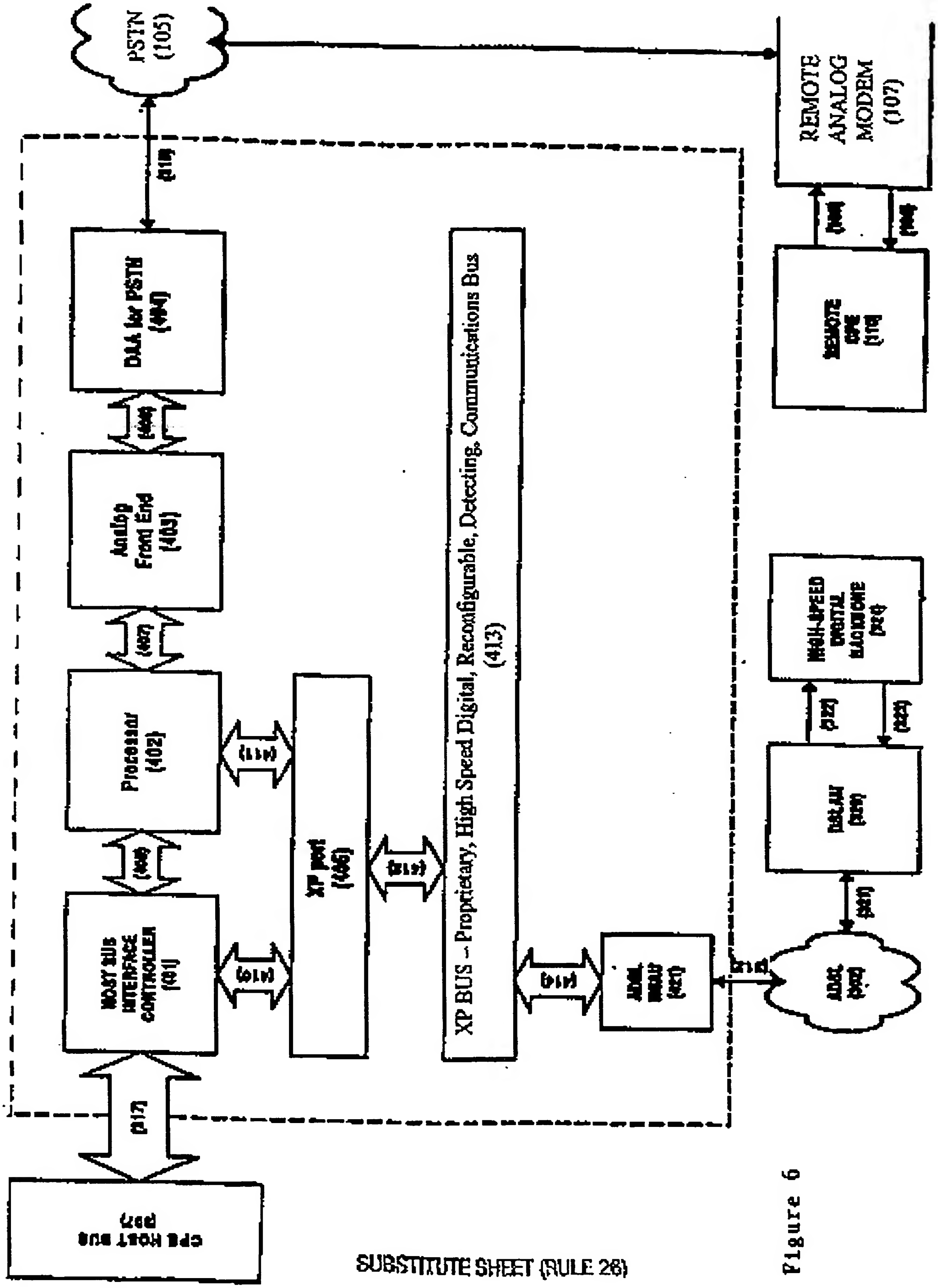

PSTN (105)
REMOTE ANALOG MODEM (107)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
XP port (406)
HOST BUS INTERFACE CONTROLLER (401)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
REMOTE CPE
HIGH-SPEED DIGITAL BACKBONE
DSLAM
ADSL
CPE HOST BUS

Figure 6

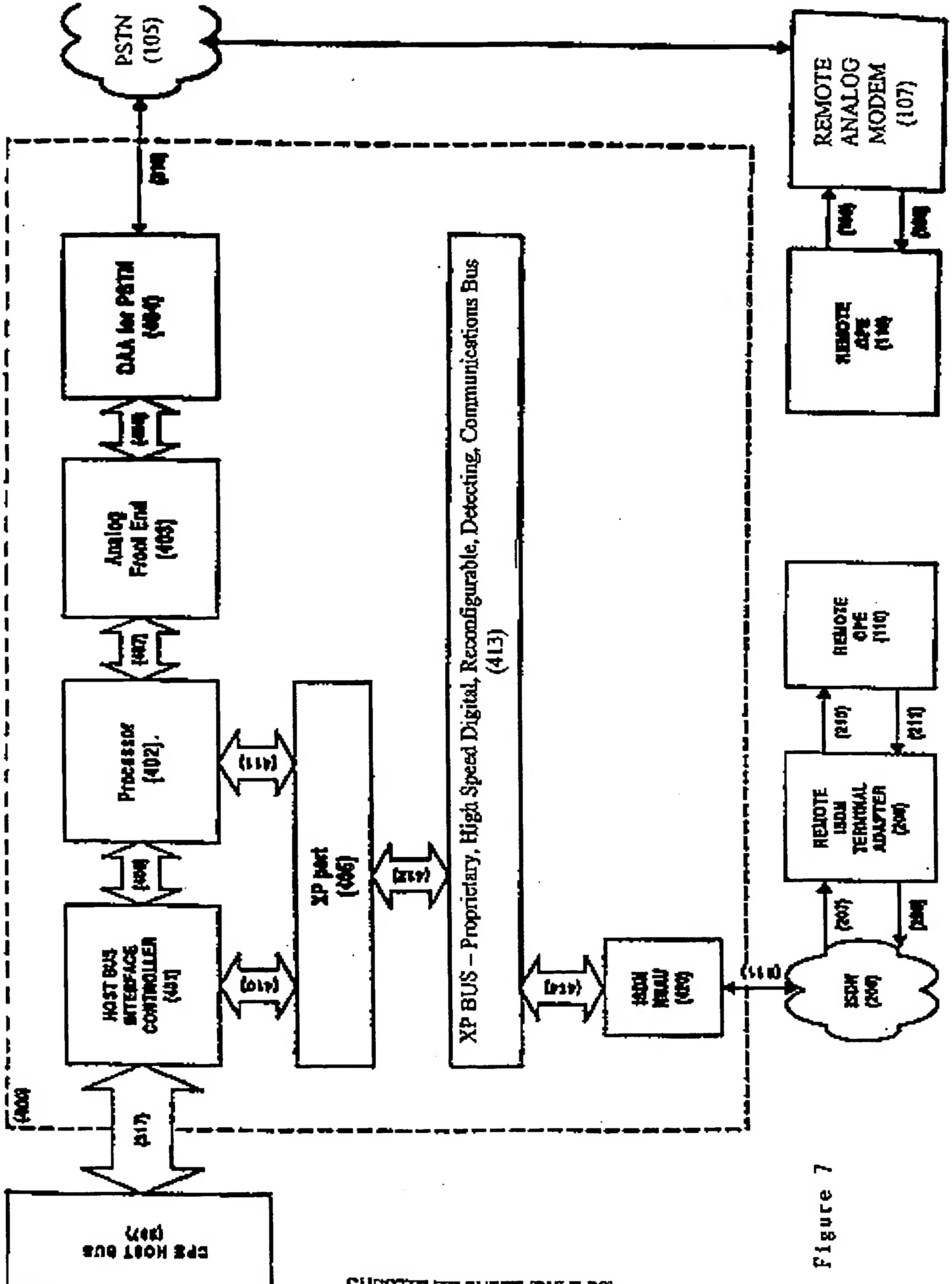

PSTN (105)
REMOTE ANALOG MODEM (107)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
HOST BUS INTERFACE CONTROLLER (401)
XP Port (406)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
REMOTE CPE (110)
REMOTE ISDN TERMINAL ADAPTER
ISDN
CPE HOST BUS
(400)

Figure 7

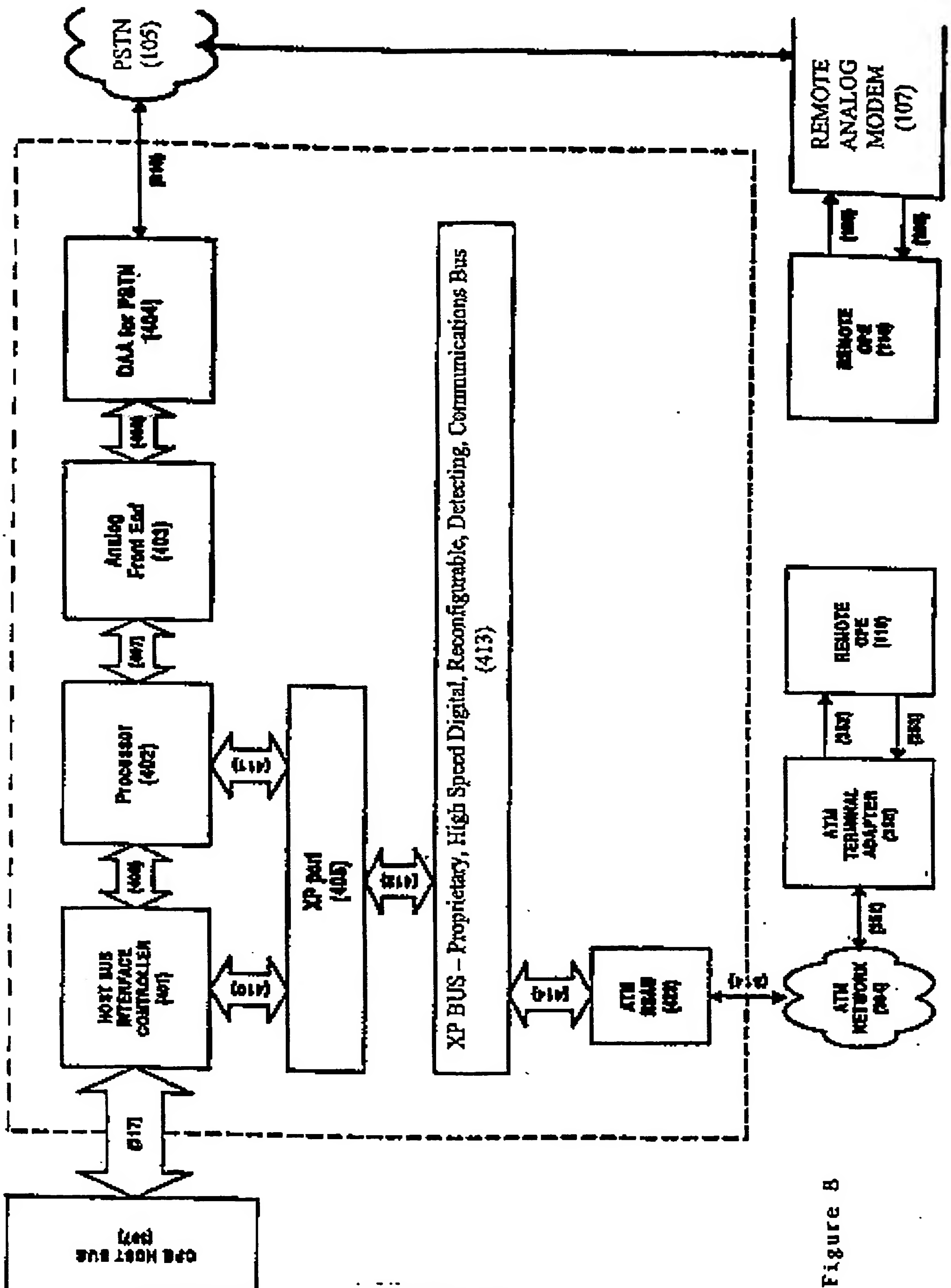
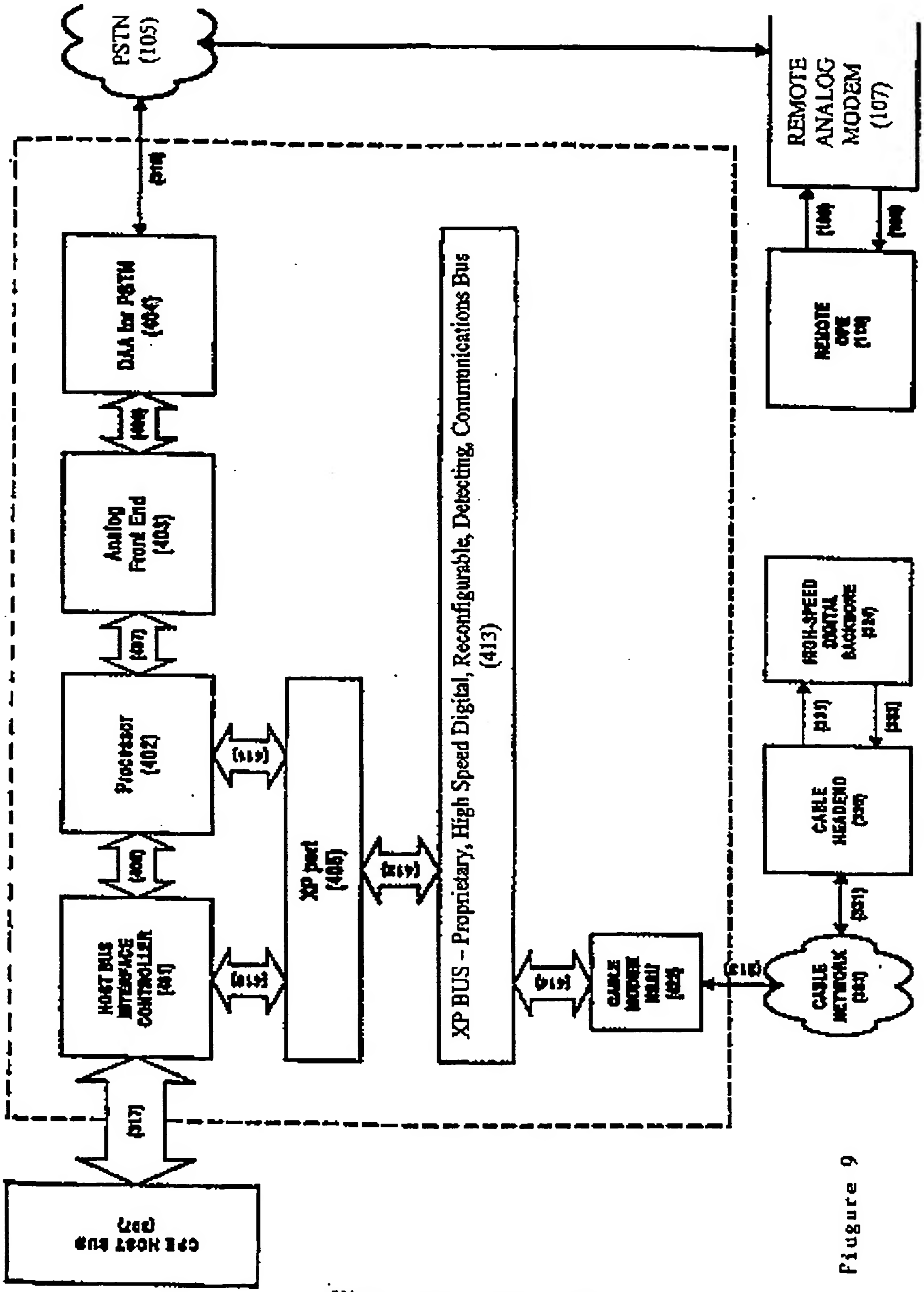

PSTN (105)
REMOTE ANALOG MODEM (107)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
XP port (405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
HOST BUS INTERFACE CONTROLLER (401)
ATM NETWORK
ATM TERMINAL ADAPTER
REMOTE CPE
CPE HOST BUS

Figure 8


PSTN
(105)
REMOTE
ANALOG
MODEM
(107)
DAA for PSTN
(404)
Analog
Front End
(403)
Processor
(402)
XP port
(405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus
(413)
HOST BUS
INTERFACE
CONTROLLER
REMOTE
CPE
HIGH-SPEED
DIGITAL
BACKBONE
CABLE
HEADEND
CABLE
NETWORK
CPE HOST BUS

Fiugure 9

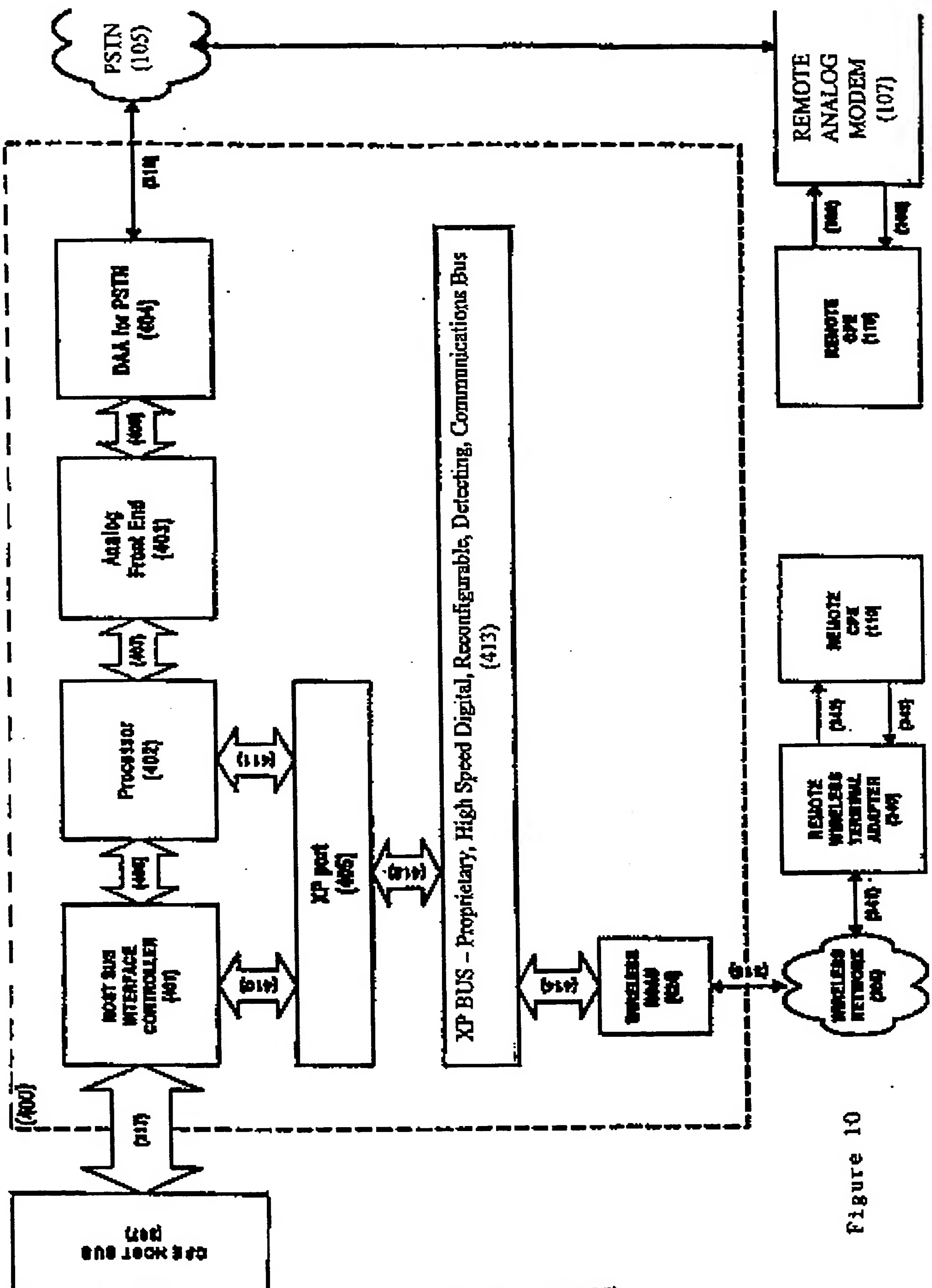

PSTN (105)
REMOTE ANALOG MODEM (107)
DAA for PSTN (404)
Analog Front End (403)
Processor (402)
XP port (405)
XP BUS – Proprietary, High Speed Digital, Reconfigurable, Detecting, Communications Bus (413)
HOST BUS INTERFACE CONTROLLER (401)
REMOTE CPE
REMOTE WIRELESS TERMINAL ADAPTER
WIRELESS NETWORK
(400)

Figure 10

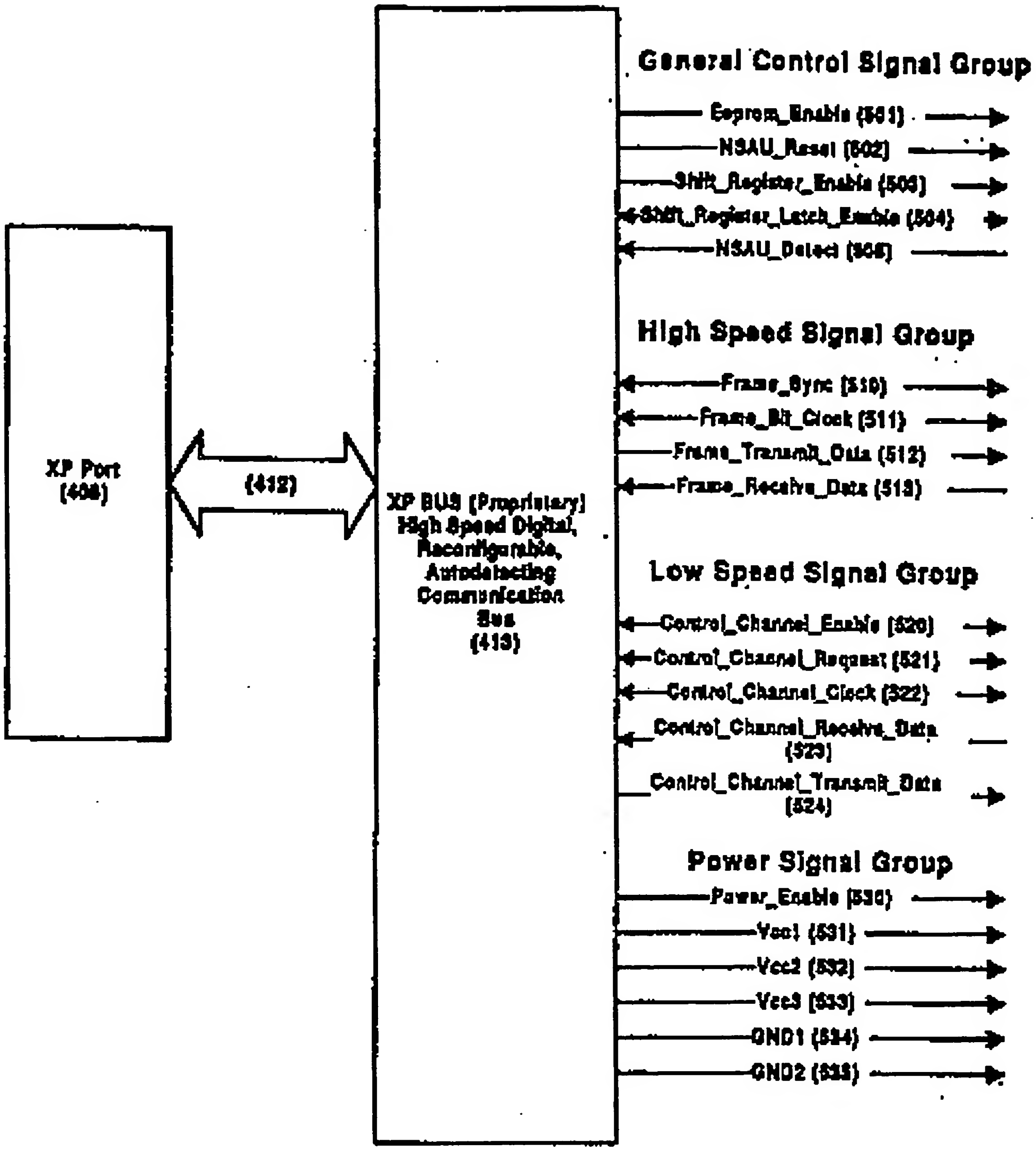


Figure 11. XP BUS Signals

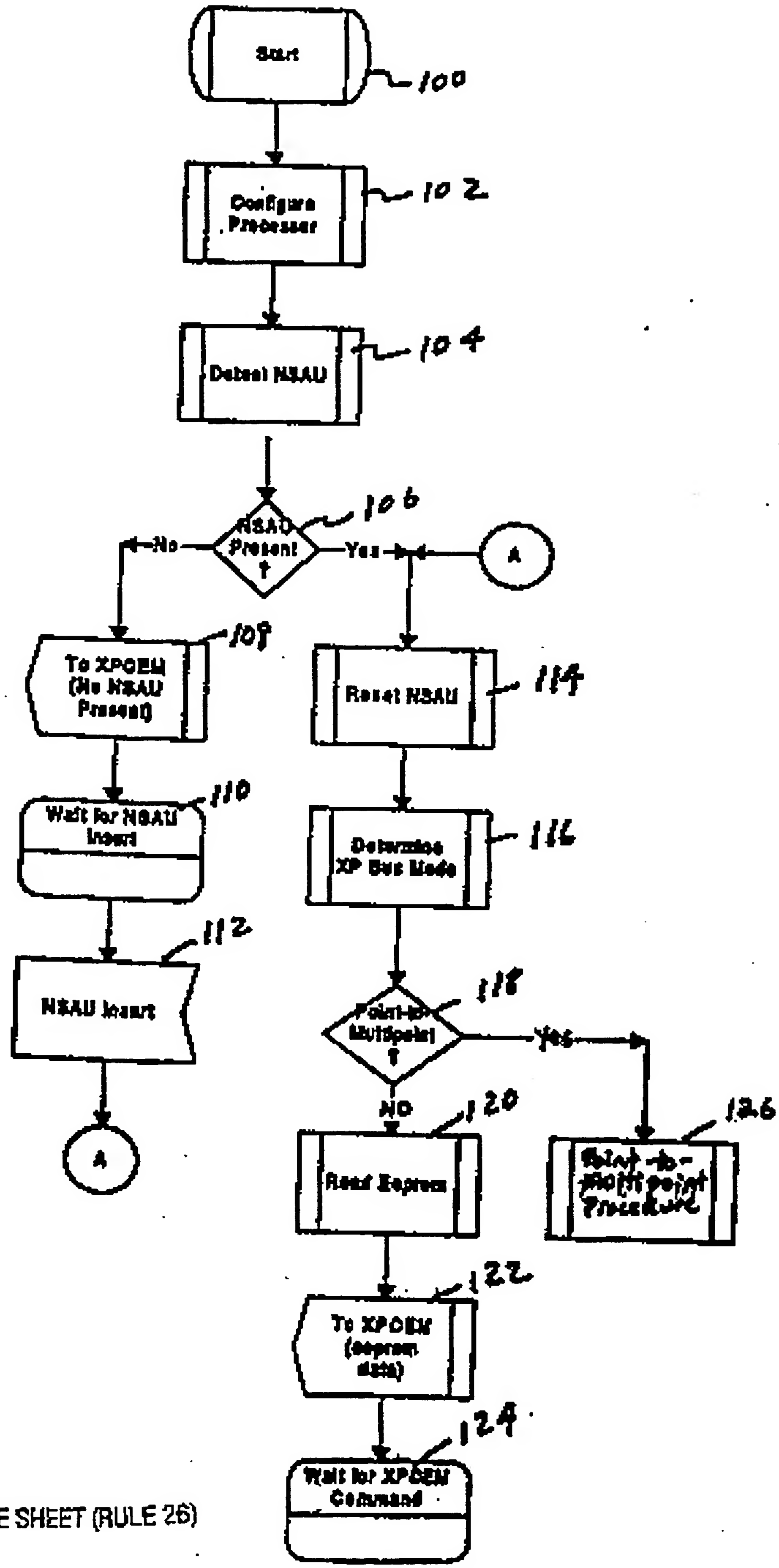

Start
100
Configure Processor
102
Detect NSAU
104
NSAU Present ?
106
No
Yes
A
To XPOEM (No NSAU Present)
108
Reset NSAU
114
Wait for NSAU Insert
110
Determine XP Bus Mode
116
NSAU Insert
112
Point-to-Multipoint ?
118
Yes
NO
120
126
A
Read Eeprom
Point-to-Multipoint Procedure
122
To XPOEM (eeprom data)
124
Wait for XPOEM Command

Figure 12A

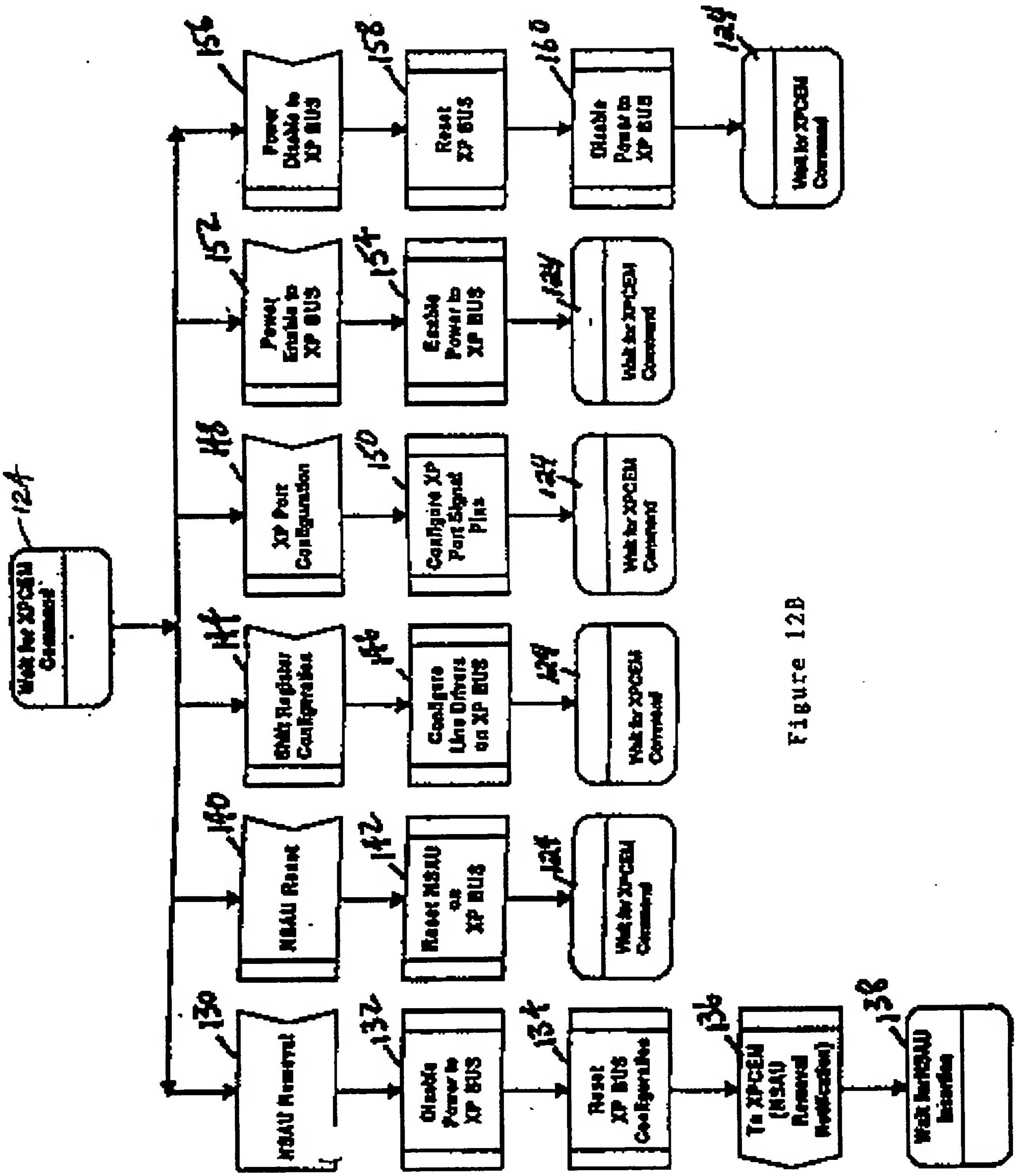

Wait for XPCEM Command
124
130
NSAU Removal
132
Disable Power to XP BUS
134
Reset XP BUS Configuration
136
To XPCEM (NSAU Removal Notification)
138
Wait for NSAU Insertion
140
NSAU Reset
142
Reset NSAU on XP BUS
124
Wait for XPCEM Command
144
Shift Register Configuration
146
Configure Line Drivers on XP BUS
124
Wait for XPCEM Command
148
XP Port Configuration
150
Configure XP Port Signal Pins
124
Wait for XPCEM Command
152
Power Enable to XP BUS
154
Enable Power to XP BUS
124
Wait for XPCEM Command
156
Power Disable to XP BUS
158
Reset XP BUS
160
Disable Power to XP BUS
124
Wait for XPCEM Command

Figure 12B

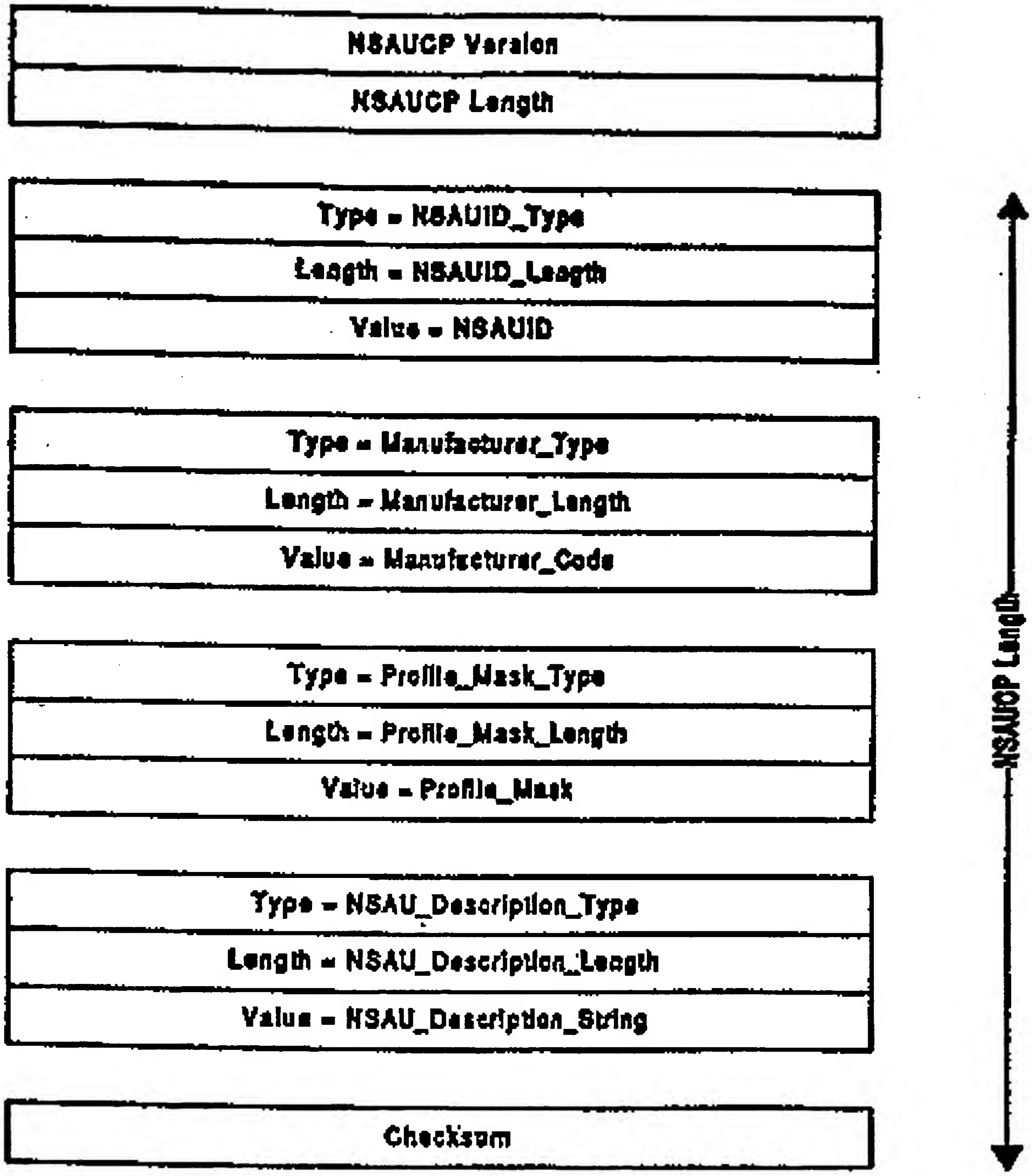


Figure 13. NSAU Capability Profile Structure